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# THE MYXOMYCETES

By THOMAS H. MACBRIDE



THE NORTH AMERICAN SLIME-MOULDS

120

# THE MYXOMYCETES

*A DESCRIPTIVE LIST OF*

THE KNOWN SPECIES WITH SPECIAL REFERENCE  
TO THOSE OCCURRING IN NORTH AMERICA

BY

THOMAS H. MACBRIDE

AND

G. W. MARTIN

STATE UNIVERSITY OF IOWA

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“Willst du dich am Ganzen erquicken,  
So musst du das Ganze im kleinsten erblicken.”

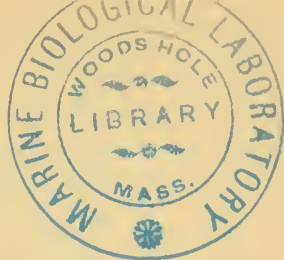
“Benutze redlich deine Zeit,  
Willst was begreifen, such nicht weit.”

GOETHE.



“Diese Kinder der Natur, welche aus einer ungeformten Gallert, und einem unsichtbaren Saamen entstehen, sind im stande, in dem sie sich nach und nach entwickeln, und ihre scheinbar nachlässige Bildung genau beobachten (lassen), eben so sehr als die schönste Pflanze, einem empfindenden Herzen die tiefe Achtung und das paradiesische Vergnügen zu verschaffen, welches einzig die Betrachtung der Heere der Natur und ihre gleichbleibende Erhaltung durch eine ewige Kraft hervorbringen kann.”

A. J. G. C. BATSCH (1783).



## PREFATORY NOTE

Taxonomy, the art of classification applied particularly to animals and plants, is conditioned largely upon structure. This, we soon learn, is the outcome of experience, the record obverse of history of a bit of life, so that correct taxonomy is reached only as we know the whole story of the object studied.

From this point of view our art enters the most fascinating, beautiful phase of science; every living thing bringing to the observer suggestion of some primal, far-off beginning. This *must* have been! Life pulsates; its forms follow the changes of the physical world; reach a certain maximum as we say, then disappear, reduced to lowest terms, to start again,—more frequently only a cell or two, which wait occasion,—good or bad—to repeat the never ceasing cycle.

As far as possible taxonomy must know these things, and more; for completion? aye for breadth of view; but more rigidly for precision, exactness more or less possibly attained.

But Nature herself, even in minor things is endlessly inexact, so that for any organism life's highway would seem to have been from the beginning nor straight nor plain. But by this it does appear all *progress* has been conditioned; endless change of place, of posture, of other environment until now! That the slime mold, a simple, uncovered, unprotected, filmy sheet or particle, should, astir with life,—some dominating urge,—should have met *all* conditions in such good fortune as still to cover the habitable earth in variety, in richness of form, and directness of behavior attracting the attention of the biologist, is a wonder indeed.

The marvel has been studied; but to modern science the myxomycetes are really new; they call for quick taxonomy, possible not to lenses only, but even in so far to the naked eye, and at this moment they kindle lively interest around the world.

In fact a new chapter here begins, a step forward in the science of our subject. True, we have not been able to open the gate to disclose creation's secret, the earliest cell from which our series rises, but we at last have opened, or at least have set ajar its homologue; we now point to the primal cell through which each new generation passes; we show the history of the *germ* from which the "cornstock" rises. The gateway for the slime mold small indeed, its width-unit  $\mu$ —the thousandth of a mm.! Yet gate it is, with all the ancient (?) furnishing;

in wondrous organization quite as in the lily or the pine,—*mitosis*; and all in the *nucleus* as required, nucleus but a fraction of the spore! Say we not well, a chapter but beginning?

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To assist in meeting such inquiry and interest is the purpose of this book. For this edition it has been to the writer's great pleasure and advantage to have the assistance of his colleague, Dr. G. W. Martin: the introduction and general editing of the text is his. By enlarging our field of inquiry, the number of species presented has been greatly enlarged. New plates were needed,—all our plates are new! To the young botanists of our continent and to our contributors around the world, the present volume is especially devoted. May they fare well!

T. H. M.

## PREFACE

Doctor Macbride's death occurred in Seattle, Washington, on March 27, 1934, after a short illness, just as the final copy for the present volume was being made ready for submission to the publishers. During the six years it has been in preparation he has taken an active part in the work, reading and criticising the manuscript and proofs, and making numerous suggestions, based on his long familiarity and wide experience with the organisms of which it treats. Many of these suggestions have been embodied in the treatment. It has been a privilege to have been associated with him in the work; it is a satisfaction to record in this place his uniform kindness and courtesy, and the inspiration of his rare personality.

In the very nature of the case, the task of which this is a part can never be complete. This publication, like others of its kind, may represent merely a milestone, marking, in so far as it is honestly and competently wrought, a certain degree of progress toward adequate understanding of the infinite variety of forms in which life has been manifest. It is offered with a keen sense of its shortcomings and limitations, but with the hope that in its turn it may serve as a new starting point for further advance.

Of the many who have shown helpful and sympathetic interest in the undertaking, mention can be made of only a few. Dean C. E. Seashore of the Graduate College of the University of Iowa has been most generous in the provision of research assistance. The assistants themselves, Dr. Frank L. Howard, Dr. H. C. Gilbert and Mr. Donald P. Rogers, have rendered valuable aid at successive stages. Upon Mr. Rogers, in particular, has fallen the burden of much of the final detail, including the checking of citations, the reading of proof and the preparation of the index. To his intelligent perception and keen interest I am indebted for the detection of numerous errors. Finally, I must acknowledge the devoted assistance of my wife, rendered in many ways throughout the progress of the work.

G. W. MARTIN.

Iowa City, Iowa,  
March 31, 1934.





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## INTRODUCTION

### I. GENERAL MORPHOLOGY

The Myxomycetes are fungus-like organisms characterized by an assimilative phase consisting of a naked, multinucleate, mobile mass of protoplasm, the plasmodium, and a reproductive phase, consisting in most instances of a membranous spore-case. The latter often contains, in addition to the spores, a system of netted or free threads, forming the capillitium, and frequently bears, within or without, calcareous accretions of specific character. The spore, on germination, emits a vesicle which gives rise to one or more swarm-spores, each with an anterior flagellum; or it may produce the swarm-spores directly. These feed and multiply, eventually function as gametes and fuse in pairs or sometimes larger groups. The zygote so produced is the first stage of the plasmodium. It grows, with multiplication of nuclei, and also in some cases, perhaps usually, by combining with other plasmodia, and under appropriate conditions, produces the fructification.

As here presented, the Myxomycetes are regarded as constituting the first and simplest class of the Fungi, coördinate in rank with the Phycomycetes, Ascomycetes and Basidiomycetes. Certain members of the group have been noted by careful observers for nearly three hundred years. Lister cites Pankow's figure and description, 1654, of the species now known as *Lycogala epidendrum*. Ray, in 1690, called the same species *Fungus coccineus* etc.; Ruppenius, in 1718, *Lycoperdon sanguineum* etc.; Dillenius, a year later, *Bovista miniata*; Buxbaum, in 1721, *Lycoperdon epidendron*. In 1729, Micheli erected the genus *Lycogala* for it and at the same time added recognizable descriptions and illustrations of several other genera and even species. But Micheli's light was too strong for his generation. As Fries, writing a century later, says "immortalis Micheli tam claram lucem accendit, ut successores proximi eam ne ferre quidem potuerint." Notwithstanding Micheli's clear distinctions, he was entirely disregarded and the little *Lycogala* was dubbed *Lycoperdon* and *Mucor* down to the end of the century. It was not until 1794 that Persoon came around to the standpoint of Micheli and wrote *Lycogala miniatum*. Fries himself, reviewing the labors of his predecessors, grouped the slime molds as a suborder of the Gasteromycetes, although clearly recognizing the peculiar character of their assimilative phase, and gave expression to

his view of their nature and position when he named the suborder *Myxogastres*. In 1833, Link, perceiving more clearly the distinctness of the group, substituted the name *Myxomycetes*. Wallroth used the name in the same year and he is usually credited with it, but he seems strangely to have confused its limitations, apparently regarding it as a synonym for the Gasteromycetes of Fries. Link's usage passed unchallenged for over a quarter of a century. The slime molds were set apart by themselves; they were fungi without question and, of course, plants.

In 1858 de Bary published the first of his noteworthy studies upon the Myxomycetes, based upon careful observation of their life cycles and particularly upon the transition between the plasmodial and fruiting stages. These studies were greatly amplified in 1859 and 1864. As a result of his investigations de Bary concluded that the relationships of the slime molds were with the amœboid protozoa rather than with the fungi, and to emphasize this viewpoint, proposed the name *Mycetozoa*—fungous animals.

In 1884 he modified the group so as to include not only the Myxomycetes of Wallroth, but the Acrasieæ of van Tieghem. Of this, more later. De Bary's name for the group has, with varying limitations, been since adopted by many distinguished authorities, including Rostafinski, Saville Kent, Zopf, the Listers and Lankester.

Whatever the position of the slime molds among living organisms may finally be determined to be, their actual study has been left almost entirely to the botanists, and particularly to the mycologists. By vote of the international botanical congresses of Vienna (1905), Brussels (1910), and Cambridge (1930), the nomenclature of the group is fixed as beginning with Linnæus' *Species plantarum* of 1753. Linnæus, to be sure, knew little about the fungi or slime molds, and apparently cared less. Nevertheless, the fixing of this date permits taking into account the work of a number of active students of the group dating from the closing years of the 18th century. Chief among these is perhaps Bulliard, in whose extensive work "*Histoire des Champignons de la France*" (1791) may be found a number of recognizable descriptions and illustrations of slime molds, unexcelled up to that time. Noteworthy references to certain species were published still earlier between 1753 and 1791 by Gleditsch (1753), Schaeffer (1762–1774), Müller (1777), Batsch (1783–1789), Leers (1789) and others. Since that time a host of students has given more or less attention to the group, of whom the outstanding names up to the time of Rostafinski are Hoffmann, Schrader, Sowerby, Persoon, Fries, Ehrenberg, Link, Fuckel, Schweinitz, Berkeley, Curtis.

The greatest taxonomic advance since Fries is embodied in the monographic treatment of Rostafinski, whose "Versuch" of 1873 was followed by the monograph of 1875 and its supplement of 1876. Rostafinski, a pupil of de Bary, followed that student's example of making intensive use of the microscope, at that time, of course, greatly improved over the crude instruments at the command of the earlier workers, although much inferior to modern apochromatic and immersion lenses. The monograph and supplement, written in Polish, were largely inaccessible to students in other countries, but were made available to English-speaking workers to a considerable extent by the works of Cooke. In 1892 Masee published his monograph, based on Rostafinski, but departing in many particulars from his treatment, and greatly increasing the number of recognized species, not infrequently on an insufficient basis. Two years later appeared the first edition of the standard English monograph, A. Lister's "Mycetozoa," revised in 1911 and again in 1925 by his daughter, Miss G. Lister. The illustrations in this work, many of them in natural colors in the later editions, have never been surpassed in comprehensiveness and in general accuracy, and it is not surprising that European treatments in other languages have largely been modelled upon this excellent work.

In North America the first extensive collections and reports were made by Schweinitz (1822; 1832). Later active collectors were Curtis, Ravenel, Ellis, Peck, Farlow, Morgan, Rex, Wingate, Thaxter, Bethel, Sturgis and Bilgram. Cooke, in 1877, published the first general account of the slime molds of the United States, followed by that of Morgan (1893-1895). The account of the slime molds of eastern Iowa (1892) and of Nicaragua (1893) by Macbride, preceded the first edition of his North American Slime-Moulds (1899). The greatly enlarged and emended second edition of this work (1922) is the basis for the present study.

As already mentioned, there has been no general agreement as to the limits of the Myxomycetes, nor is there one at present. A number of groups of doubtful position have been regarded as related to the slime molds by some authors, but excluded by others. De Bary, as already noted, included the Acrasieæ. This curious group of organisms, first studied by van Tieghem, resembles the Myxomycetes in the possession of a naked amœboid stage, but its members possess neither swarm-spores nor a true plasmodium. Just before fructification the amœbæ become aggregated but do not lose their individual identity; can, in fact, readily be shaken apart in water. Their resemblance to the Myxomycetes seems to be superficial only, and most recent workers have been inclined to doubt their close relationship.



The Plasmodiophoraceæ includes Plasmodiophora and several other genera parasitic on vascular plants. They show several points of resemblance to the Myxomycetes, especially in the character of the zoospore with its apical flagellum. On the other hand they entirely lack the secreted sporangial wall and the capillitial threads found in most of the true slime molds and have been held to possess a distinctive type of nuclear division. Schroeter (1886, p. 133) erected the order Phytomyxini to contain them and his classification has been extensively followed. The tendency among recent authors, e. g., Gäumann (1926), Gäumann and Dodge (1928) and Fitzpatrick (1930) has been to include them among the lower Phycomycetes.

The Labyrinthuleæ is a curious group of organisms of uncertain position, containing two genera and a small number of species, and characterized by an assimilative phase known as a net plasmodium, which is thought by Zopf (1885) to be intermediate in character between the aggregate amœboid mass of the Acrasiæ, and the plasmodium of the true slime molds. Much more study is required before these organisms can be placed in a satisfactory relationship with other forms, but at the present time the evidence does not warrant including them in the Myxomycetes.

Jahn, in one of the most recent general treatments of the Myxomycetes (1928), excludes the Acrasiæ and Plasmodiophoraceæ from the group, but includes the order Hydromyxales, a small group of aquatic organisms, of which Vampyrella is the best known genus. The order is divided into two families. In the less specialized, the Plakopodaceæ, there is no suggestion of a plasmodium, but it is included because of its probable relationship with the other family, the Vampyrellaceæ. The latter possesses a multinucleate, naked assimilative phase which Jahn regards as a plasmodium similar to that of the slime molds. The manner of life and the reproduction are so different from those of the slime molds that it seems best to exclude this group also, pending fuller information.

This leaves, then, two major divisions in the Myxomycetes, the Exosporeæ and the Myxogastres or Endosporeæ. The structure and life-histories of these two groups, here ranked as subclasses, is sufficiently different to make it desirable that they be considered separately.

1. *Exosporeæ*. Represented by a single genus, *Ceratiomyxa*. Several species have been described, but the fructification is so variable that it seems better to include them all as varieties and forms of a single species, *C. fruticulosa*. This is extremely common, found on decaying wood throughout the greater part of the world. The plasmodium is at first colorless, then white, or occasionally pinkish or bluish, and lives

within the wood; upon what it feeds, or how it grows, little is known, although it has recently been demonstrated that it may feed to some extent, at least, upon bacteria. When ready to fruit the plasmodium appears at the surface and proceeds to form erect sporophores. These may be poroid or clavate, or dendroid and elaborately branched, with all intermediate conditions. While the sporophores are in process of formation, according to Jahn the bulk of the nuclei undergo reduction division, the rest degenerating, as in the *Myxogastres*. When the sporophores are mature, the surface becomes marked off into polyhedral, uninucleate protospores, each of which becomes elevated upon a slender stalk and is transformed at the tip into a smooth-walled, elliptical spore. Within the spore, the nucleus divides twice mitotically, so that at maturity the spores are 4-nucleate. Upon germination the contents of the spore emerge as an amœboid body which may produce short pseudopodia. The nuclei shortly divide again and the whole mass becomes separated into eight uninucleate portions each of which develops a flagellum and swims off as a pyriform swarm-cell. The nuclei of the younger sporophores seem to be diploid, those of the swarm-cells haploid. According to Jahn (1908), fusion occurs at the time the plasmodium emerges from the wood. Olive (1907) claims that fusion occurs just before the formation of the protospores and regards the first two divisions in the spore as constituting the reduction divisions. H. C. Gilbert has recently demonstrated, however, that fusion occurs between the swarm-cells, and supports Olive's view as to the place of reduction division.

2. *Myxogastres*. This subclass includes all of the slime molds except *Ceratiomyxa*,—some four hundred species. The fructification is characterized by a wall which surrounds the spores and other internal structures. The wall may be thick or thin and relatively permanent or quickly fugacious, but it is always present. The spores are uninucleate when formed normally, but the nucleus may divide before germination. They are small, more often under than over  $10\ \mu$  in diameter, and enclosed in a cellulose membrane. This is rarely smooth, usually finely or coarsely echinulate or verrucose, or reticulate. The spore markings are rather constant in a given species and hence serve as useful taxonomic characters. In spite of their small size, the spores are extremely tenacious of life. E. C. Smith, who has investigated this phase of their life-history intensively, reports germination of the spores of a number of species, from collections left in the herbarium for from ten to thirty-two years (1929); later, in correspondence, he has extended the upper limit to forty-four years.

Germination of most species takes place fairly readily in tap water or

distilled water, but their behavior is often highly erratic, so that the accounts of different students are not in complete accord either as to the fact of germination in a given species or as to the time and manner. Nearly all agree that the spores of *Reticularia lycoperdon* and *Fuligo septica* germinate quickly and easily, as do those of many species of *Physarum*. Other forms germinate slowly and with difficulty. Among the factors which seem to influence germination are the age of the spores, the circumstances under which they were formed and the H-ion concentration of the medium. Doubtless others will be added.

At germination the spore wall breaks and from one to four swarm-cells emerge. Sometimes the protoplasmic contents pass out as a vesicular mass and then become differentiated into one or more swarm-cells. The swarm-cell is comma-shaped, with an anterior flagellum attached by its base to a bell-shaped body adjoining the anterior nucleus. The posterior end is more or less amœboid and contains a large vacuole. The swarm-cell moves in a jerky fashion in a more or less spiral path, feeding on bacteria and fungus spores, and probably taking in nutrient materials in solution when such are present. Eventually it settles down, loses its flagellum and divides into two similar cells which develop flagella. This process may continue for some time but eventually the swarm-cells function as gametes, fusing in pairs. The zygote thus produced is the first stage of the young plasmodium. It feeds and grows and the nuclei divide. It may also fuse with other plasmodia. Cienkowski (1863), who gave the plasmodium its name, believed it always arose from the fusion of numerous swarm-cells, but recent studies throw doubt upon this. Wilson and Cadman (1928) show that in *Reticularia lycoperdon* swarm-cells which have failed to fuse may be incorporated into the zygote, but they serve as food-materials, the nuclei being destroyed and absorbed with the protoplasm. This, of course, alters the conception of a plasmodium as Cienkowski interpreted it and as it has been incorporated in the literature; but the term is so useful as a designation for the naked, multinucleate, assimilative phase of the slime molds that it seems well to retain it in its altered sense. There can be no question that large plasmodia fuse. When grown in culture, a single plasmodium in its progress across the substratum may break up into two or more separate plasmodia. These usually meet sooner or later and become completely incorporated without the least difficulty. It cannot be regarded as proved, however, that the origin of the plasmodium is always from the fusion of two gametes. Schünemann (1930), working with *Didymium nigripes* and other species, showed that several swarm-cells may unite to form a plasmodium with haploid nuclei and that nuclear fusion occurred in

the young plasmodium, thus confirming in part Cienkowski's observations.

At any time after germination of the spores, unfavorable conditions may cause the swarm-cells or myxamœbæ to cease their activities. Each becomes surrounded by a hyaline wall, forming a microcyst, which remains dormant until favorable conditions again appear, when it gives rise to a swarm-cell.

The determination of the manner of the multiplication of the nuclei in the plasmodium has offered certain difficulties. Many years ago J. J. Lister (A. Lister, 1893) demonstrated mitotic division of the nuclei in *Badhamia utricularis* and since that time there have been occasional observations in other species. So many attempts to secure this stage failed, however, that there arose a widespread belief that many of the divisions must be amitotic. Both Schünemann and Howard (1932) have recently shown that division may be completed within twenty minutes or half an hour and that it occurs nearly simultaneously throughout a large plasmodium. This demonstration explains why so many attempts to find it have failed. There is no reason to doubt that indirect nuclear division is the rule and that direct division rarely, if ever, occurs.

In a number of cases the food of the plasmodium is known to consist of solid material. As early as 1877, A. Lister observed that the plasmodium of *Badhamia utricularis* was parasitic upon a species of *Corticium*, publishing his notes upon the behavior of this species and of *Brefeldia maxima* in 1888. *Physarum polycephalum* has been repeatedly grown upon the hymenium of agarics in the laboratories of the University of Iowa since the 90's. A number of other instances of proved or suspected parasitism upon the hyphæ and hymenia of the higher fungi have since accumulated. These are summarized by Howard and Currie (1932) who add extensively to the number, list fifteen species known to be parasitic, and report extensive experiments using a wide range of Hymenomycetes as substrata. Several species have been grown in pure culture; among others, *Didymium difforme* (Skupienski, 1926, 1927, 1928) and *Didymium nigripes* (Cayley, 1929). F. A. Gilbert (1928) has shown that the swarm-spores of *Dictydialium plumbeum* may be nourished not only by soluble material but by bacteria and the spores of fungi. Watanabe (1932) experimented with seventeen species of slime molds and sixteen species of bacteria and found that all the slime molds could utilize bacteria to some extent as food but that there was great variation in the range of bacteria acceptable to different species, and in the reactions of the slime molds to them.



To speak of such organisms as saprobes is obviously inaccurate. In many species the plasmodium spends its life within the tissues of decaying wood, probably feeding partly on bacteria, fungous hyphæ and spores and perhaps protozoa; in a considerable number of species the plasmodium may be found on the surface of decaying leaves or fragments of woody débris. Very early in its development, the plasmodium begins to manifest its tendency to become divided into vein-like branches which redivide and then become reunited to form a more or less fan-shaped network with a continuous layer of protoplasm at the advancing margin. The structure of the plasmodium is not uniform; there is an outer, hyaline region surrounding the inner granular portion and it is in the latter that the nuclei are found, so that the outer portion seems to perform essentially the functions of the wall of the thallus in one of the larger Phycomycetes. The protoplasm of the interior exhibits a series of pulsating movements, flowing first in one direction, then in the other, but the movement is always a little stronger in the direction in which the plasmodium as a whole is moving. As it progresses over the substratum a shell of waste material and secreted matter is left, marking the position of the principal veins and suggesting collapsed hyphæ.

Because of the ease of securing relatively large amounts of protoplasm free from cell-walls and other skeletal material, the plasmodia of slime molds have often suggested themselves as favorable material for the chemical study of protoplasm. Kiesel (1930) points out that the auxiliary and associated materials ordinarily used in other cells for accessory purposes are present in plasmodia; hence the assumption that plasmodia exhibit more pure protoplasm than other cells or protoplasmic masses is without adequate basis. Because, however, the associated materials are incorporated in the general mass, the colloidal elements of the protoplasm are exposed and easily accessible.

In color, the plasmodia vary from hyaline or white through yellow, orange, red, violet, blue, green and brown. Pallid grays, yellows and browns are perhaps the commonest colors. While the color of the plasmodium is fairly constant for a given species, it is subject to considerable variation, even in the same plasmodium, upon different substrata and at different stages of development. Hence, while plasmodial color is of some value as a taxonomic criterion, it must be used with caution. Solacolu (1932) has shown that the myxomycete pigments have the properties of anthracenes, which are of common occurrence in fungi as in plants, but of doubtful occurrence in animals.

The changes through which the plasmodium passes in becoming transformed into a fructification have been followed in a number of



species, and while the details vary there is much that all the species studied have in common. Bulliard, as far back as 1791, noted and illustrated certain external features of this process but it was not until 1859 that de Bary attempted to trace the details in the case of *Fuligo septica*. Recent careful studies combining morphological and cytological detail are those on *Reticularia lycoperdon* and *Physarum polycephalum* already cited. The process varies somewhat, depending upon the nature of the fructification, whether plasmodiocarpous or sporangiate.

An *æthaliium* may be defined as a slime mold fructification in which all or a considerable part of a given plasmodium is involved, and in which differentiation has not proceeded to the delimitation of separate sporangia. It must, therefore, be distinguished from a pseudo-æthaliium, as found in species of Tubifera and species such as *Stemonitis confluens*, where the sporangia are delimited but borne in compact and more or less attached groups.

The *plasmodiocarp* may tentatively be regarded as less primitive than the æthaliium because it merges into the sporangiate type of fructification. Further investigation may show, however, that it is more primitive, and that both the sporangiate and æthalioid types represent modifications of the plasmodiocarpous. In the typical manifestations of the plasmodiocarp, as illustrated, e. g., by *Physarum serpula* or *Hemitrichia serpula*, the protoplasm is aggregated into a few of the larger veins as they rest upon the surface of the substratum, and there becomes transformed into a fructification which has the interior structure of a sporangium, but which retains the netted form and outline of the plasmodium. In species with distinct sporangia the plasmodium often assumes such a netted form before breaking up into the primordia of the sporangia. The plasmodiocarp tends to become shorter and less branched and thus merges by gradual degrees through linear and pulvinate fructifications into the sporangiate type.

The *sporangium* is typically an erect fructification of definite form and structure for a given species, each sporangium representing only a small part of the protoplasm of a given plasmodium, hence sporangia tend to be grouped in clusters or extensive masses, the entire group representing the area occupied by the fruiting plasmodium. Discarded remnants of the plasmodium usually remain at the base of the sporangia, forming the hypothallus; sometimes in definite sheets, as in the stemonites, less definite in the lower layer of plasmodiocarpous or æthalioid fructifications. In *Diachea leucopodia* it appears as the arrested network of the fruiting plasmodium. In other species, repre-

senting various groups, it shrinks to a small disk-like base at the foot of each sporangium. Only rarely is it entirely absent. The sporangia may be sessile or stalked, and the stalk, when present, may be solid, and then usually horny or calcareous, or hollow, when it is commonly filled with waste material or spore-like cells. Not infrequently the stalk is prolonged into the interior of the sporangium as a conical, cylindrical or swollen *columella*. The columella is particularly well developed in *Stemonitis*, *Comatricha*, *Lamproderma* and related genera.

The essential parts of the sporangium are the enclosing wall and the mass of spores. In addition a *capillitium* is often present, composed of netted tubes or thread-like processes. The sporangium wall is not cellular in structure but is in the nature of an excretion. In some species it is relatively constant in thickness and appearance; in others it is variable, the differences being presumably due to variations in the external environment during its formation. In most species of *Stemonitis* and *Comatricha* it is exceedingly delicate and disappears as soon as the sporangium is mature. In *Arcyria* the upper portion is broken into flakes by the expanding capillitium and falls away, leaving only the persistent cup-like base. In the crateriums and in many of the badhamias, physarums and didymiums it remains for a long time, while in the didermas it is often well preserved long after the spores have been discharged.

The capillitium is sometimes completely lacking, as in *Licea* and *Cribraria*. In *Badhamia* it is in the form of a network of limy tubes; in *Physarum* and related genera the lime is aggregated into nodules which are connected by a network of nearly or quite limeless tubules. In *Stemonitis*, *Comatricha* and *Lamproderma* the capillitium arises as branches of the columella. In *Hemitrichia* and *Arcyria* it takes the form of a network of elaborately sculptured tubes, while in *Trichia* the threads are like those of *Hemitrichia*, but shorter and separate. In *Lycogala*, *Reticularia* and *Enteridium* a true capillitium is lacking but its place is taken by a pseudocapillitium composed of coarse tubes or frayed or perforated plates. The distinction is based on the method of formation, the true capillitium being formed of materials laid down by intra-protoplasmic secretion on the walls of vacuoles or tubular invaginations, while the pseudocapillitium is the direct product of the degeneration of a portion of the protoplasm itself. Since the development of only a comparatively small number of species has been studied, the mode of formation of the capillitium must in most instances be inferred, but the differences between the two structures are such as to lead to little uncertainty in practice.

The plasmodium does not always proceed to fructification without interruption. Under the influence of dryness, cold, lack of food-materials and probably other unfavorable conditions it may become transformed into a hard, horny resting stage, or sclerotium. Within the sclerotium, the protoplasm is aggregated in masses containing a number of nuclei. In such condition the plasmodium may remain dormant for a considerable length of time, presumably over winter in most species of temperate climates, and in some cases at least for two or three years, resuming activity with the advent of favorable conditions.

The Myxomycetes are of no direct economic importance. The exclusion of the Plasmodiophoraceæ removes the only group of plant parasites. From time to time certain species appear on economic plants—*Physarum gyrosum* on sweet potato vines, *Physarum cinereum* on strawberry plants and lawn grass—but while they may alarm the proprietor, they do no harm and soon disappear. A recent study by Thom and Raper (1930) shows that myxamœbæ and plasmodia are constantly present in the upper layers of soil and in the decaying vegetable débris at the surface, and these authors note that members of this group should be considered in studying soil microorganisms. Active as they are, their rôle should be investigated, but nothing definite can be said to be known of it at present.

## II. COLLECTION AND CARE OF SPECIMENS

On this subject a word may here be appropriate. Throughout the world, specimens may be gathered at the proper season in almost any locality. Beginning with the latter part of May or first of June, in the northern United States, plasmodia are to be found everywhere on piles of organic refuse: in the woods, especially about fallen rotting logs, undisturbed piles of leaves, beds of moss, stumps, by the seeping edge of melting snow on mountain sides, by sedgy drain or swamp, nor less in the open field where piles of straw or herbaceous matter of any sort sink in undisturbed decay. Within fifty years tree-planting in all the prairie states has greatly extended the range of many more definitely woodland species, so that the species of *Stemonitis*, for instance, are common in the groves on farms far into Nebraska and Dakota. In any locality the plasmodia pass rapidly to fruit, but not infrequently a plasmodium in June will be succeeded in the same place by others of the same species, until the cold of approaching winter checks all vital phenomena. The process of fruiting should be watched as far as possible, and for the herbarium material, allowed to pass to perfection in the field.

Specimens collected should be placed immediately in boxes in such a way as to suffer no injury in transport; beautiful material is often ruined by lack of care on the part of the collector. Once at the herbarium, specimens may be mounted by gluing the supporting material to the bottom of a small box. Boxes of uniform size and depth may be secured for the purpose. Some collectors prefer to fasten the specimen to a stiff paper, of a size to be pressed into the box snugly, but which may be removed at pleasure. Every care must in any case be taken to exclude insects. Against such depredators occasional baking of the boxes on the steam radiator in winter is found to be an efficient remedy, or paradichlorobenzene may be sprinkled in the boxes or herbarium cases two or three times a year. In the United States National Herbarium specimens are mounted on the inside of the cover of boxes  $1\frac{3}{4} \times 4 \times \frac{7}{8}$  inches, the label and the specimen thus being inseparable. The shallow cover permits ready examination of the material with lens or binocular microscope. Such boxes fit snugly in a shallow box the size of an herbarium sheet, five of which fit easily into a standard herbarium shelf. This method, while somewhat wasteful of space in the case of very small collections, is admirably suited to the great majority of collections, and permits their filing in strict order. It has been adopted for the bulk of the collections in the herbarium of the State University of Iowa. This collection, which has served as the basis for the present work, contains, in addition to the accumulations of many years by the authors and their colleagues and associates, the invaluable Morgan and Wingate collections. Included also are noteworthy gatherings by Ellis, Farlow, Shimek, Rex, Bilgram, Hagelstein, Harvey, Bethel, H. C. Gilbert and O. A. Plunkett in America, and Sydow, Japp, Brandza and Meylan in Europe. An interesting series of duplicates of the collections of O. F. Cook from Liberia, secured by exchange with the United States National Herbarium, is also included. The study of this material has been checked by examination of that in other institutions, particularly the splendid collection in the United States National Herbarium. Mr. Lister and Miss Lister have courteously given portions of certain critical or doubtful species for comparison.

For simple microscopic examination it will be found convenient first to wet the material with alcohol on the slide, then with a weak solution of potassium hydroxide (2-3%) to cause the spores and other structures to assume proper plumpness. A little glycerine may be added or run under the cover if it is desired to preserve the material for further or prolonged study. For permanent mounting nothing is better than glycerine jelly in most cases. As a preparation the material



Careful comparison of spores from fructifications kept in a saturated atmosphere and mounted in water, with those mounted in weak potassium hydroxide shows that there is no appreciable difference between the measurements made of spores mounted in these two ways, and since the KOH is much more rapid, it is ordinarily used. In the case of some genera, e. g., *Cribraria*, *Dictydium* and many of the *Trichiales*, the addition of the alkali produces a marked color change. This may sometimes be avoided by substituting lactic acid. Many fructifications contain large spore-like bodies, often somewhat irregular in shape, which are the result of failure of the protoplasm to proceed to complete division. In measuring spores, these bodies must be excluded. If the spores are on the whole uniform in size, an average of ten measurements may be taken as representative of the collection. Where the spores are more variable, a larger number of measurements must be made.

In the matter of nomenclature, the attempt has been made to adhere to the rules of the International Botanical Code. In certain instances, where the rules permit some degree of latitude, the authors have preferred to err on the side of strictness rather than laxity. It is believed that in the long run this will be more likely to lead to nomenclatorial stabilization than the greater freedom permitted, but scarcely encouraged, by the rules.

[illegible][illegible]

Decision as to the limits of species and genera must necessarily be a matter of personal judgment, and this is perhaps more apparent in the slime molds, because of their obvious responsiveness to environmental conditions while the fructifications are forming, than in most other groups. We have felt justified in applying a distinctive specific name to any form which shows reasonable constancy under varying conditions, even though occasional intermediate forms may appear. The multiplication of varieties has nearly if not quite reached the saturation point. Many of the varieties listed in the literature are obviously merely growth forms; some are doubtless autonomous species. If the latter, they will eventually be recognized as such; if the former, it would seem better to modify the diagnosis of the species to accommodate them, rather than to multiply names.

The space devoted to synonymy is extensive. It is unfortunate that this should be so, but at present it seems to be necessary. Many synonyms are listed on the authority of earlier students, particularly Rostafinski, and in view of the scanty and inadequate descriptions given in many of the earlier works, many must be regarded as doubtful. Where possible, however, the original descriptions have been consulted, and the attempt has been made to judge their value impartially. We have included either in the synonymy or the appendix many published names which have been applied to slime molds, even certain names not validly published but which have appeared in the literature. If they do nothing else, such compilations help to prevent the publication of invalid names, and, in case of doubt, send the student to original sources for verification of conclusions.

# THE MYXOMYCETES

## SUBCLASS EXOSPOREÆ *Rost.*

Versuch 2. 1873.

Fructification composed of stalk-like, membranous, columnar, simple or branching sporophores or sometimes pore-like folds. Spores white, stalked, borne superficially on the surface of the sporophores. A single genus:

### *Ceratiomyxa* *Schroeter*

in Engler & Prantl, Die nat. Pflanzenfam. 1 (i) : 16. 1889.

*Ceratium* Alb. & Schw., Consp. Fung. 358. 1805, *non* Shrank 1793.

Sporangia none; spores superficial, colorless, on erect papillæ or branches or on the inside of minute depressions or pits, each spore surmounting a delicate pedicel or stalk. Mature spore 4-nucleate, on germination giving rise to a rounded amoeboid body, which, after another nuclear division becomes transformed into eight flagellated swarm-cells. Plasmodium inhabiting sodden wood, emerging to form the fructification.

The spores, in manner of formation and of germination, differ widely from those of the other genera, with which their homologies seem obscure. It has been suggested that the pedicels represent incipient stipes; the spores primitive or simplified sporangia.

Several species have been described but they all seem to merge into each other and thus to be variants of a single species, too inconstant to deserve even varietal recognition for the most part, although in deference to custom the varieties are here listed.

### CERATIOMYXA FRUTICULOSA (*Muell.*) *Macbr.*

N. A. Slime-Moulds 18. 1899.

Pl. I, Figs. 1, 2, 3, 4, 5.

1777. *Byssus fruticulosus* Muell., Fl. Dan. 6 : 718.

1778. *Tremella hydnoidea* Jacquin, Misc. 1 : 145.

1783. *Clavaria puccinia* Batsch, Elench. Fung. 139.

1791. *Clavaria byssoides* Bull., Champ. France 209, pl. 415, fig. 2.

1791. *Puccinia byssoides* (Bull.) Gmelin, Syst. Naturæ 2 : 1462.



1794. *Isaria mucida* Pers., Roemer N. Mag. Bot. 1 : 121.  
 1805. *Ceratium hydroides* (Jacq.) Alb. & Schw., Consp. Fung. 358.  
 1805. *Ceratium pyxidatum* Alb. & Schw., Consp. Fung. 359.  
 1879. *Ceratium fuscum* Cooke, Grev. 8 : 60.  
 1879. *Ceratium roseum* Cooke, Grev. 8 : 60.  
 1880. *Ceratium sphaeroideum* Kalch. & Cooke, Grev. 9 : 22.  
 1885. *Ceratium mucidum* (Pers.) Schroet., Krypt. Fl. Schles. 3 (1) : 101.  
 1889. *Ceratiomyxa mucida* (Pers.) Schroet., in Engler & Prantl, Die nat. Pflanz. 1 (i) : 16.

Plasmodium usually colorless, sometimes yellow, rosaceous, greenish or bluish; sporophores white or occasionally yellowish, pinkish or bluish, forming on the substratum mold-like patches composed of the simple or branched sporiferous pillars, 1–10 mm. tall, sometimes more; spores borne externally on slender individual stalks, hyaline, very variable in shape and size but commonly oval or elliptical,  $8\text{--}14 \times 6\text{--}8 \mu$ .

World-wide in distribution and extremely common, occurring especially after warm showers and in sultry weather. The spores vary from spherical to oval, elliptical and occasionally to pyriform and somewhat allantoid. Some fructifications bear spherical or short elliptical spores only  $7\text{--}8 \mu$  in diameter, but great variation in both shape and size may be found among the spores borne on a single stalk. Some of these variations are doubtless due to different degrees of maturity.

Micheli's figure of 1729 is as good as that of Mueller. The latter referred the species to the Linnæan genus *Byssus*, which included algæ as well as fungi. The same thing is true of *Tremella*, which is now definitely restricted to the *Heterobasidiomycetes*. All the other genera with which the genus has been associated, down to *Ceratiomyxa*, are now otherwise applied. Mueller's specific name seems to have undisputed priority.

The extreme variability of the species has led to the proposal of a number of varieties as well as specific segregates. These all merge into one another, but the following forms seem for the present to merit recognition as varieties.

Var. *arbuscula* Berk. & Br. (*Ceratium arbuscula* Berk. & Br., Jour. Linn. Soc. 14 : 97, 1873). This is a form in which each sporophore has a single short stalk which becomes profusely branched in tree-like fashion.

Var. *filiforme* Berk. & Br. (*Ceratium filiforme* Berk. & Br., Jour. Linn. Soc. 14 : 97, 1873). This variety is characterized by very long, slender sporophores, sometimes unbranched for 3–4 mm. then branching profusely in a tuft at the top, the branches of the neighboring

sporophores interlacing to form a dense mat concealing the substratum and covering an area several centimeters square. Most common in the tropics of both hemispheres.

Var. *porioides* Alb. & Schw. (*Ceratium porioides* Alb. & Schw., Consp. Fung. 359, 1805; *Ceratiomyxa porioides* (Alb. & Schw.) Schroet. in Engler & Prantl 1 (i) : 16). Sporophores confluent, porose; pores ample, angular, at length radiate-dentate. *Ceratium crustosum* Berk. & Curt., Grev. 3 : 62, 1874, is merely a crustose form of this variety. The var. *porioides* has frequently been regarded as a distinct species and it ordinarily appears to be so, but cases occur in which it and the typical form arise together from the same plasmodium, hence the attribution of a yellow plasmodium to this variety cannot be regarded as significant. Widespread and fairly common, but not so frequent as the typical form.

Var. *cæsia* Jahn (*Ceratiomyxa cæsia* Jahn, Ber. Deutsch. Bot. Ges. 36 : 660, 1919) is similar to var. *porioides*, but tinged with green, and developing from a bright blue-green plasmodium. It has been reported only from Germany.

*Ceratiomyxa freyana* Meylan (Bull. Soc. Vaud. Sc. Nat. 56 : 65, 1925) is described as arising from a bright yellowish green or citron yellow plasmodium and as occurring in scattered small patches. In other respects it seems not to differ from typical *C. fruticulosa* and judging by the description is doubtfully distinct. It has been reported from Switzerland and Rumania.

#### SUBCLASS MYXOGASTRES *Fries ex Macbr.*

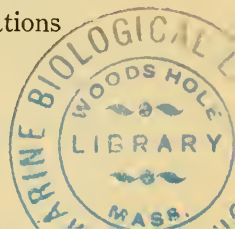
1829. Suborder *Myxogastres* Fries, Syst. Myc. 3 : 67.

1833. Suborder *Myxomycetes* Link, Handb. der Gew. 3 : 405.

1858. Class *Mycetozoa* de Bary, Bot. Zeitung 16 : 369, in part.

1889. Class *Myxogasteres* Schroet., in Engler & Prantl 1 (i) : 8, in part.

The slime molds included in this subclass are characterized by abundant, minute, unicellular spores, enclosed in more or less perfectly defined sporangia and often accompanied by peculiar thread-like or tube-like structures, free or variously attached and joined, forming the capillitium. The spores on germination give rise either to swarm-cells, or to amœbulæ, which directly or by division give rise to swarm-cells. After one or more divisions the swarm-cells function as gametes, conjugating in pairs, the resultant amœboid zygotes constituting the young plasmodia. These feed voraciously, the nuclei dividing as they enlarge. They also probably fuse with each other, and, when the proper conditions arise, become transformed into the fructifications typical of the several species.



## KEY TO ORDERS OF THE MYXOGASTRES

- a. Spore mass black or deep violaceous, rarely ferruginous or pallid; capillitium always present. . . . . *b*
- a. Spore mass usually brown or yellow, sometimes purplish or rosy, very rarely blackish brown; capillitium present or absent. . . . . *c*
- b*. Peridium or capillitium, or both, calcareous. . . . . Order PHYSARALES
- b*. Peridium and capillitium usually limeless; lime if present restricted to hypothallus, stipe and columella. . . . . Order STEMONITALES
- c*. True capillitium none or scanty (except in genus *Alwisia*); pseudocapillitium often present, of tubules or perforated plates which sometimes fray out into threads; spores pallid, brown or purplish. . . . . Order LICEALES
- c*. Capillitium thread-like, more or less distinctly sculptured, parietal or free; spores pallid or yellow. . . . . Order TRICHIALES

The sequence is intended to suggest that the presence of lime indicates less complete specialization and that the elimination of lime by the plasmodium at the outset, before fructification, is indicative of higher rank. The circumstance that the excreted lime may sometimes serve a protective purpose does not vitiate the general principle. The differentiation reaches a climax in the sculptured capillitium of the trichias.

## ORDER PHYSARALES

Spores violaceous black in mass; violaceous or violaceous brown by transmitted light. Capillitium typically delicate and thread-like, sometimes charged with lime, in one genus tubular and calcareous throughout. Peridium simple or double, usually limy.

The presence of calcareous deposits, either in the capillitium or the peridium or the stalk, often in all three, is the chief diagnostic character of the order. Elsewhere similar deposits occur in the genus *Diachea* only, in this treatment placed in the Stemonitales, but by Lister and others placed in the Physaraceæ, and clearly intermediate in its relationships.

Two families:

## KEY TO FAMILIES OF PHYSARALES

- Capillitium more or less calcareous, usually reticulate or anastomosing in intricate fashion; calcareous deposits often affecting entire fructification. . . . . PHYSARACEÆ
- Capillitium non-calcareous, usually less intricate; calcareous deposits affecting the peridium only, or the peridium and the stipe. . . . . DIDYMIACEÆ

## FAMILY PHYSARACEÆ

Capillitium more or less calcareous, the lime typically in the form of nodules connected by tubular hyaline threads, sometimes calcareous throughout; peridium usually more or less incrustated, and often the stipe. Spores violaceous black in mass; purple or lilaceous brown by transmitted light.

## KEY TO THE GENERA OF THE PHYSARACEÆ

- a. Fructification æthalioid. . . . . 1. *Fuligo*
- a. Fructification plasmodiocarpous or of separate sporangia. . . . . b
  - b. Capillitium composed of a network of tubules, calcareous throughout. . . . . 2. *Badhamia*
  - b. Capillitium of hyaline threads connecting nodules of lime. . . . . c
- c. Peridium obviously calcareous. . . . . d
- c. Peridium appearing nearly limeless. . . . . h
  - d. Fructification long-cylindrical, branching, pendent. . . . . 3. *Erionema*
  - d. Fructification plasmodiocarpous and appressed to substratum, or of sessile or stalked sporangia. . . . . e
- e. Dehiscence circumscissile or by a definite lid. . . . . 5. *Craterium*
- e. Dehiscence irregular. . . . . f
  - f. Fructification plasmodiocarpous or of distinct sporangia, the latter subglobose, laterally appressed or gyrose, but the peridium not introverted. . . . . 4. *Physarum*
  - f. Fructification rarely plasmodiocarpous, usually of stalked sporangia, with the peridium more or less introverted. . . . . g
- g. Sporangia saucer-shaped, fragile; dehiscence irregular. . . . . 6. *Trichamphora*
- g. Sporangia thimble-shaped, rarely plasmodiocarpous; dehiscence by petal-like lobes. . . . . 7. *Physarella*
- h. Plasmodiocarpous; capillitium with free, hooked branches. . . . . 8. *Cienkowskia*
- h. Sporangia distinct, ovoid; peridium shining. . . . . 9. *Leocarpus*

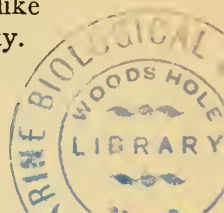
1. *Fuligo* Haller emend. Pers.

Syn. Meth. Fung. 159. 1801.

1768. *Fuligo* Haller, Hist. Stirp. Helv. 3 : 110, in part.

1809. *Æthaliium* Link, Mag. Ges. Nat. Fr. Berl. 3 : 42.

Fructification æthalioid, occasionally subplasmodiocarpous, forming a pulvinate or less commonly a subglobose mass composed of interwoven and poorly defined tubes, each with a calcareous crust; the outer layer sterile, usually calcareous, forming a fragile crust or cortex, sometimes nearly or quite wanting; the basal layer a membranous hypothallus, the intermediate portion containing the spores and capillitium and the limy tube walls; capillitium of hyaline, thread-like tubules connecting lime-knots, as in *Physarum*, often rather scanty.





Haller seems to have been the first to recognize the genus. Persoon defined it more closely and illustrated it. Link merely translated the name into Greek and in this was followed by Fries.

The structure of the central sporiferous region is difficult to interpret. It is commonly regarded as composed of tortuous, interlaced sporangia, but it seems more reasonable to regard these bodies as more in the nature of plasmodiocarps, representing the principal veins of the plasmodium which have matured without proceeding to the sporangial stage. The walls of these bodies, whatever their nature, to a considerable extent take the place of a capillitium and hence form a pseudocapillitium in addition to the true capillitium formed within them.

The taxonomy of the genus is likewise perplexing. Are the various forms simply phases of a single species or to what extent are they sufficiently constant in their admitted variety to claim specific rank and separate description? To follow the example of Greville and recognize in all the literature of two centuries varied descriptions of a single type—this were perhaps the easier and speedier disposal of the case. Fries thought so to treat the problem but was unable to keep faith with his own decision, for he no sooner states the genus monotypic then he proceeds to offer four varieties, the same as those recognized by Persoon and others as species. More recent students seem to find convenience in specific division, thus indicating that to careful observers all over the world there are differences that may be and have been recognized again and again. It will be said, was said by Fries, that these variations are insignificant, “pendent ex æris constitutione”; but as a matter of fact the several types here described may be found on the same day in similar habitats, so that evidently something other than atmospheric environment must determine their final aspect. However it may be, there are many varying presentations of *Fuligo* capable of illustration and description. Some of these forms we venture to describe, with such annotation as may show something of present knowledge.

#### KEY TO THE SPECIES OF *FULIGO*

- a. Spores predominantly elliptical; fructification plasmodiocarpous or æthalioid; crust white . . . . . 1. *F. cinerea*
- a. Spores predominantly spherical; fructification æthalioid; cortex various . . . . . b
- b. Æthalia small, usually 1 cm. or less in diameter . . . . . 2. *F. muscorum*
- b. Æthalia larger, usually 2 cm. or more in diameter . . . . . c
- c. Spores mostly 6–9  $\mu$ , always under 10  $\mu$  . . . . . 3. *F. septica*
- c. Spores 11  $\mu$  or larger . . . . . d

- d. Cortex thin, fragile, not calcareous, grayish or brownish, often wanting; spores 11–13  $\mu$ , nearly smooth. . . . . 4. *F. intermedia*  
 d. Cortex thick, spongy, calcareous; spores 15  $\mu$  or over, rough-tuberculate. . . . . 5. *F. megaspora*

### 1. FULIGO CINEREA (*Schw.*) *Morg.*

Jour. Cin. Soc. Nat. Hist. 19 : 33. 1896.

Pl. I, Fig. 11.

1832. *Enteridium cinereum* Schw., Trans. Am. Phil. Soc. II. 4 : 261.  
 1832. *Lachnobolus cinereus* Schw., Trans. Am. Phil. Soc. II. 4 : 261.  
 1875. *Badhamia coadnata* Rost., Mon. 146.  
 1876. *Physarum ellipsosporum* Rost., Mon. App. 10.  
 1885. *Æthaliopsis stercoriformis* Zopf, Pilzthiere 150.  
 1887. *Fuligo stercoriformis* (Zopf) Racib., Hedwigia 26 : 111.  
 1894. *Fuligo ellipsospora* (Rost.) Lister, Mycetozoa 67.

Fructification usually more or less plasmodiocarpous, long, widely effused, thin, applanate, often reticulate, from a few millimeters to 2–3 centimeters in extent; cortex white, firm, membranous, but rather thick; capillitium well developed, with large and irregular calcareous nodules; spores lilaceous brown, elliptical, subspherical or spherical, rather coarsely spinulose, 14–16  $\times$  11–12  $\mu$ . Plasmodium milk-white, watery, changing to cinereous.

In shaded situations on piles of rotting straw or manure, or on detritus in the woods, especially that of bracken. Some of the spores are nearly or quite spherical but the majority are elliptical. Rostafinski called it first a *badhamia*, then a *physarum*; Zopf founded for it a new genus *Æthaliopsis*. Recent students are agreed that it is better included in *Fuligo*. Large, gray, pulvinate forms with small spherical spores are often found in herbaria labelled *F. cinerea* but usually prove, on examination, to be *F. septica* var. *candida*.

Not common in eastern North America, but extremely common in the coniferous forests of the northwest. Occurring also in Europe, Asia, Africa.

### 2. FULIGO MUSCORUM *Alb. & Schw.*

Consp. Fung. 86. 1805.

Pl. I, Figs. 9, 10.

1809. *Lignidium griseoflavum* Link, Mag. Ges. Nat. Fr. Berl. 3 : 24.  
 1817. *Lignidium muscicola* Fr., Symb. Gast. 10.  
 1829. *Reticularia muscorum* (Alb. & Schw.) Fr., Syst. Myc. 3 : 91.  
 1875. *Physarum gyrosum* Rost., Mon. 111, in part.  
 1876. *Licea ochracea* Peck, Rept. N. Y. State Mus. 28 : 55.  
 1879. *Fuligo ochracea* Peck, Rept. N. Y. State Mus. 31 : 56.  
 1879. *Fuligo simulans* Karst., Bidr. Kann. Finl. Nat. 31 : 108.  
 1888. *Physarum muscorum* (A. & S.) Berl., in Saccardo, Syll. Fung. 7 : 346.

*Æthalia* pulvinate or somewhat globoid, irregular, small, usually 1 cm. or less in width; cortex very thin, gray or greenish yellow, bearing scattered deposits of yellow lime nodules; internal walls frequently not evident; capillitium well developed, the numerous fusiform or branching calcareous nodes yellow, ochraceous or sometimes nearly white, connected by rather short hyaline threads; spores violet-brown, coarsely, somewhat irregularly and not very closely warted, 11–13  $\mu$ . Plasmodium yellow.

The above description is based mainly on material from northern New York said by Rex to agree with specimens of *Fuligo ochracea* Peck in the New York State Museum. The distinctive characters, aside from the small size, seem to be the dull greenish or gray peridium, with its scattered deposits of yellow lime and the strongly but sparsely warted spores.

New York, New England, Ontario; Europe, Ceylon. Reported from Manchuria by Skvortzow, 1931, but the description given makes the report doubtful.

### 3. *FULIGO SEPTICA* (L.) Weber

Wigg. Pr. Fl. Holsat. 112. 1780.

Pl. I, Figs. 6, 7, 8.

- 1763. *Mucor septicus* Linn., Sp. Plant. ed. 2. No. 1656.
- 1763. *Mucor ovatus* Schaeff., Fungi Bav. 132, fig. 192.
- 1772. *Mucor mucilago* Scop., Fl. Carn. 2 : 492.
- 1791. *Reticularia carnosus* Bull., Champ. 85, pl. 424, fig. 1.
- 1791. *Reticularia hortensis* Bull., Champ. 86, pl. 424, fig. 2.
- 1791. *Reticularia lutea* Bull., Champ. 87, pl. 380, fig. 1.
- 1794. *Fuligo flava* Pers., Roemer N. Mag. Bot. 1 : 88.
- 1796. *Fuligo vaporaria* Pers., Obs. Myc. 1 : 92.
- 1799. *Fuligo pallida* Pers., Obs. Myc. 2 : 36.
- 1801. *Reticularia ovata* (Schaeff.) Wither., Br. Pl. ed. 4. 4 : 463.
- 1801. *Reticularia septica* (L.) Wither., Br. Pl. ed. 4. 4 : 463.
- 1801. *Fuligo laevis* Pers., Syn. Meth. Fung. 160.
- 1803. *Fuligo flavescens* Schum., Enum. Pl. Sæll. 2 : 194.
- 1809. *Æthelium flavum* (Pers.) Link, Mag. Ges. Nat. Fr. Berl. 3 : 42.
- 1825. *Fuligo cerebrina* Brond., Mem. Soc. Linn. Paris 3 : 74.
- 1826. *Reticularia vaporaria* (Pers.) Chev., Fl. Par. 1 : 342.
- 1826. *Fuligo varians* Somm., Fl. Lapp. 239.
- 1827. *Æthelium violaceum* Spreng., Syst. Veg. 4 : 533.
- 1829. *Æthelium septicum* (L.) Fr., Syst. Myc. 3 : 93.
- 1885. *Fuligo tatrica* Racib., Hedwigia 24 : 169.

*Æthelium* pulvinate, rarely more or less plasmodiocarpous, varying in size but usually large, up to 20 cm. or occasionally more in its largest diameter, and 1–3 cm. thick; color white, yellowish ochraceous, green-

ish ochraceous, tawny, brown or deep violet; cortex fragile, calcareous, thick or almost lacking; capillitium of white, yellow or reddish lime-knots, connected by hyaline, thread-like tubules, usually well developed but not infrequently scanty; spore-mass dull black, sooty; spores purplish brown by transmitted light, mostly spherical, spinulose to nearly smooth, 6–9  $\mu$  in diameter. The plasmodium is usually yellow, but may be white or cream colored.

An extremely variable species, as the extensive synonymy suggests, and because of its large size and frequent occurrence on spent tan bark, the typical form has long been familiar and popularly known as "flowers of tan." It was described under this name in 1727 by Marchant, and again described and illustrated by Micheli in 1729. The classical studies of de Bary (1859, 1864) give much attention to the development of this species. World-wide in its distribution, it appears in its various manifestations in all sorts of exposed situations—logs, posts, stumps, the bark of living trees, even clods of earth and stones. The typical form (var. *ovata* of N. A. Slime-Moulds, ed. 2) is common on stumps and fallen logs, with us on oak, cottonwood, linden and maple particularly, but may occur on a variety of substrata, including bare earth. The fructification is large, yellow, ochraceous or tawny, with an extremely friable, foamy cortex. The calcareous internal structure is white. The spores are spherical, nearly smooth and 6–8  $\mu$  in diameter. Bulliard figures this phase well on pl. 424, fig. 2, as *Reticularia (Fuligo) hortensis*. Schaeffer's pl. 132 probably represents the same thing, as does Bolton's pl. 134. Sowerby's fig. 2 on pl. 399, and figs. 1 and 2 on Greville's pl. 272 possibly also depict this form. Persoon calls this *F. vaporaria* because it frequents hotbeds and the like, and believes it to represent the "*untuosus flavus*" of Linnæus, although he thinks Schaeffer's specimens do not.

The following phases seem to be sufficiently constant to warrant varietal recognition:

Var. *candida* Pers. (as *F. candida* Pers., Obs. Myc. 1 : 92, 1796). Plasmodium, æthaliium and lime-knots white, giving the whole structure a grayish white appearance when mature. Plasmodiocarpous forms of this are likely to be confused with *F. cinerea*, from which they may be distinguished by the small, spherical spores. Common.

Var. *rufa* Pers. (as *F. rufa* Pers., Roemer N. Mag. Bot. 1 : 88, 1794, = *F. carnea* Schum., Enum. Plant. Sæll. 2 : 194, 1803; *Reticularia carnea* (Schum.) Fr., Syst. Myc. 3 : 91, 1829; *Reticularia rufa* (Pers.) Schw., Trans. Am. Phil. Soc. II. 4 : 261, 1832; *Æthaliium ferrincola* Schw., Trans. Am. Phil. Soc. II. 4 : 261, 1832; *Æthaliium rufum* (Pers.) Wallr., Fl. Crypt. Germ. 11 : 341, 1833; *Licea lindheimeri*



Berk., Grev. 2 : 68, 1873; *Tubulina lindheimeri* (Berk.) Mass., Mon. 42, 1892). *Æthelium* usually thick and rather solid; much less flattened in proportion to its size than the typical form; the cortex is porose but firm, orange at first, becoming tawny with age, often exhibiting two distinct layers; the interior grayish; the spores 6–7  $\mu$ . Bulliard figures it well on pl. 380, fig. 1, and Sowerby's fig. 1 on pl. 399 is also good, as is Greville's fig. 3 on pl. 272, showing the two colors mentioned. Not uncommon in the forest, from June to September. Meylan believes it a valid species.

Var. *lævis* Pers. (as *F. lævis*). Similar to preceding, but usually smaller, with a smooth, rusty brown, persistent cortex, which remains when all the grayish sporiferous mass has been distributed. A forest form, more apt to be found in the autumn, but appearing in July.

Var. *flava* Pers. in sense of Morgan. Yellow or yellow-green; wide-spread, but thin, the cortex yellow but extremely evanescent; the capillitium yellow throughout. On fallen logs in moist dark woods. Not common. The spores of most collections of the var. *flava* tend to average somewhat larger than those of the other varieties, 8–8.5, occasionally 9  $\mu$ .

Var. *violacea* Pers. (as *F. violacea*). Plasmodium dark red or wine colored; *æthelium* thin, 5–8 cm. broad; cortex at first dull red and very soft, at length almost wholly vanishing so that the entire mass becomes purple-violet, with the upper surface varied with white; capillitium rather open, of more or less inflated, large irregular nodes joined by long, slender, transparent filaments. Spores dark violet, minutely roughened, spherical, about 7.5  $\mu$ . Ontario, Tennessee, Wisconsin, Oregon. Probably widespread, but rarely noticed. Professor Morgan regarded this as a well-defined species. In our material it seems more distinct than the other varieties and may prove to be a good species.

#### 4. *FULIGO INTERMEDIA* Macbr.

N. A. Slime-moulds ed. 2. 30. 1922.

Pl. I, Fig. 12.

1911. *Fuligo cinerea* var. *ecorticata* Lister, Mycetozoa ed. 2. 88.

*Æthelium* 2–3 cm. in greatest diameter, or occasionally somewhat larger, 0.5–1 cm. thick, covered with a thin, fragile, but not calcareous, yellowish gray or brownish cortex; spore-mass gray or violaceous to nearly black, firm, not sooty, the limy plates running through the mass somewhat calcareous, intricate; capillitium inconspicuous; spores globose, pale purple, faintly warted, 11–13  $\mu$ .

The firm spore-mass and the moderately large spores serve to dis-

tinguish this from some forms of *F. septica* to which it bears a close resemblance; the spherical or slightly irregular but not at all elliptical spores from *F. cinerea*.

Apparently western: Iowa, Colorado, Montana, New Mexico, Arizona, Oregon.

## 5. *FULIGO MEGASPORA Sturgis*

Colo. Coll. Pub. Sc. Ser. 12 : 443. 1913.

Pl. I, Fig. 13.

*Æthalia* pulvinate, 15–40 cm. in diameter, covered with a thick spongy incrustation of lime, white, or yellowish toward the base; interior of convolute tubes, the walls membranous, brittle, charged throughout with white granules of lime 1.5–2  $\mu$  in diameter; capillitium scanty, of delicate, colorless, anastomosing tubules bearing toward the center large, white, branching calcareous nodules; spores spherical or somewhat oval or irregular in outline, dark purplish brown, rough-tuberculate, the surface markings often united into branching lines forming an irregular and incomplete reticulation, 15–20  $\mu$ .

To the naked eye the *æthalia* suggest *F. septica* var. *candida*, but the large, dark, irregularly roughened and often subreticulate spores distinguish it at once. A collection from New Mexico by Bethel, noted as occurring directly on the hot desert sands as well as on the trunks of *Juniperus*, is noteworthy for the extreme density and firmness of the calcareous portion of the fructification and the paucity of spores.

Colorado, New Mexico, Florida; Africa. Not common.

## 2. *Badhamia* Berk. emend. Rost.

Mon. 139. 1875.

1852. *Badhamia* Berk., Trans. Linn. Soc. 21 : 153.

Sporangia simple or rarely plasmodiocarpous; peridium thin, breaking irregularly; capillitium composed of anastomosing tubules, forming a network which is calcareous throughout, the nodes often only slightly enlarged; stipe, when present, membranous or hair-like; columella present or absent; spores in some species adherent in clusters.

The genus is closely related to *Physarum* but may ordinarily be distinguished easily by the wholly calcareous capillitium. Individual collections occur in which the capillitium may be more or less physaroid. Brandza (1926) cites certain extreme instances of this as a response to the external conditions under which the sporangia are formed. Howard (1931) shows that the capillitium of *Physarum*

*polycephalum*, in its development, goes through a badhamioid stage. We are therefore justified in regarding *Badhamia* as the more primitive of the two genera. Usually the distinction is readily apparent in the mature sporangia.

## KEY TO THE SPECIES OF BADHAMIA

- |   |                           |
|---|---------------------------|
| a. Spores adherent in firm, globose clusters.....   | b                         |
| a. Spores free or only slightly and irregularly adherent.....                                     | f                         |
| b. Spores elliptical or oval.....   | 1. <i>B. versicolor</i>   |
| b. Spores spherical or pyriform.....  | c                         |
| c. Sporangia yellow.....  | 2. <i>B. nilens</i>       |
| c. Sporangia gray or white.....   | d                         |
| d. Stipitate, rarely sessile; stipe short, dark.....  | 3. <i>B. papaveracea</i>  |
| d. Usually sessile; stipe, when present, yellow or straw colored.....                             | e                         |
| e. Sporangia gray, walls thin, translucent, white when empty; spores warted.....                  | 4. <i>B. capsulifera</i>  |
| e. Sporangia white, rarely pale rose, calcareous; spores sometimes marked by bands or ridges..... | 5. <i>B. populina</i>     |
| f. Spores tending to adhere somewhat, but not in regular clusters; iridescent.....                | 6. <i>B. utricularis</i>  |
| f. Spores wholly free.....  | g                         |
| g. Spores ovoid; sporangia white or ochraceous, minute.....                                       | 8. <i>B. ovispora</i>     |
| g. Spores typically spherical.....  | h                         |
| h. Sporangia yellow or yellowish.....   | i                         |
| h. Sporangia gray, white or iridescent.....   | j                         |
| h. Sporangia pale lilac or brown.....   | r                         |
| i. Sessile; dull yellow.....  | 9. <i>B. decipiens</i>    |
| i. Stipitate; yellow-green or gray with a yellow base.....  | 10. <i>B. viridescens</i> |
| j. Spores warted with overlying coarse reticulation.....  | 14. <i>B. gracilis</i>    |
| j. Spores not reticulate.....   | k                         |
| k. Sporangia flattened; discoidal to annulate or plasmodiocarpous.....                            | 12. <i>B. orbiculata</i>  |
| k. Sporangia not greatly flattened, pulvinate, hemispherical or subspherical.....                 | l                         |
| l. Sporangia gray, iridescent, borne on long, slender, flaccid, straw-colored stalks.....         | 7. <i>B. magna</i>        |
| l. Stipes shorter, or lacking.....  | m                         |
| m. Spores usually over 15 $\mu$ .....   | 11. <i>B. affinis</i>     |
| m. Spores usually under 15 $\mu$ .....  | n                         |
| n. Sporangia ashy, heaped; spores very dark, coarsely and densely spiny.....                      | 15. <i>B. cinerescens</i> |
| n. Sporangia paler; spores more finely spinulose.....   | o                         |
| o. Sporangia white, stained with yellow or brown below; spores dark, spinulose, 12-15 $\mu$ ..... | 13. <i>B. macrocarpa</i>  |
| o. Sporangia without yellowish stains; spores paler, smoother and smaller.....                    | p                         |
| p. Capillitium dense, usually massed in center to form a pseudocolumella.....                     | 16. <i>B. panicea</i>     |
| p. Capillitium less dense, not forming a pseudocolumella.....                                     | q                         |

- q.* Sporangia usually sessile, sometimes with a short, yellowish, flaccid stalk; spores dusky violaceous. . . . . 17. *B. foliicola*  
*q.* Always sessile on a broad base; spores grayish lilac; alpine. . . . . 18. *B. alpina*  
*r.* Sporangia pale lilaceous, rarely white; spores roughly warted or subreticulate. . . . . 19. *B. lilacina*  
*r.* Sporangia grayish brown, stipitate; spores dark, roughened, 12–14  $\mu$ . . . . . 20. *B. rubiginosa*  
*r.* Sporangia darker, sessile; spores roughly warted, 15–18  $\mu$  21. *B. subaquila*

## 1. BADHAMIA VERSICOLOR *Lister*

Jour. Bot. 39 : 81. 1901.

Pl. I, Fig. 14.

Sporangia minute, 0.2–0.5 mm. in diameter, scattered or clustered, gray, flesh colored or occasionally white, sessile, the calcareous deposits slight; capillitium white or apricot colored; spores ovoid 10–12  $\times$  8–9  $\mu$ , arranged in clusters of 10 to 40, forming hollow spheres or ellipses, dull purple and minutely warted at the broad end, elsewhere paler and nearly smooth.

This little species, as it comes to us, is gray, very uneven in size and somewhat irregular in form and habit. The capillitium in our specimens is white. The spores furnish the distinguishing character. They are sometimes globose, about 9–10  $\mu$ . Most of them are definitely and permanently affected in shape by the fact of cluster-association, narrower in the direction of the cluster center. In typical forms, in which they occur in hollow spheres, they are not pyriform or conical as in other species with clustered spores, but oval in outline. Specimens from Colorado referred here by Dr. Sturgis have the spores in smaller solid clusters, easily broken apart. They may be distinct.

On the bark of living and dead trees, and on mosses and lichens in such situations. Colorado, Ontario; Great Britain, Germany, Switzerland, Rumania, India.

## 2. BADHAMIA NITENS *Berk.*

Trans. Linn. Soc. 21 : 153. 1852.

Pl. II, Figs. 16, 17.

1852. *Badhamia pallida* Berk., Trans. Linn. Soc. 21 : 153.

1863. *Badhamia inaurata* Currey, Trans. Linn. Soc. 24 : 156.

Sporangia gregarious or closely crowded, globose or depressed-globose, 0.5–1 mm. in diameter, yellow, greenish yellow or grayish green, rugulose, sessile; capillitium yellow, forming an open net with occasional thickenings at the nodes; spores clustered, delicately roughened, violaceous brown, 10–12  $\mu$ . Plasmodium yellow.



This resembles *Badhamia decipiens* except for the clustered spores, and the more commonly aggregate habit. The spores, as usual when clustered, are conspicuously warted on the outer side, as noted by the author of the species. In a collection from Isle Royale, Mich. (Univ. Mich. Herb. Fl. 125) the peridium is double, the outer crustose layer splitting away from the membranous inner layer and tending to expand in petal-like lobes.

Michigan, Colorado, Montana, Oregon, California, West Indies, South America; Ceylon, various parts of Europe.

Var. *reticulata* G. List., Trans. Brit. Myc. Soc. 5 : 71, 1914, forming simple or netted plasmodiocarps on moss on the trunks of living trees, occurs in Iowa, the West Indies and in the old world.

### 3. BADHAMIA PAPAVERACEA Berk. & Rav.

Grev. 2 : 66. 1873.

Pl. II, Figs. 18, 19.

1894. *Badhamia hyalina* (Pers.) Berk. var. *papaveracea* Lister, Mycetoza 30.

Sporangia gregarious, globose or ovate, 0.7–1 mm. in diameter, stipitate, iridescent-gray; peridium thin, translucent, and containing but little calcareous deposit, smooth or slightly rugulose; stipe very short, but generally distinct, black or very dark brown; hypothallus none; capillitium a network of large meshes with expanded nodes, prominent, white, persistent after the spores have been blown away; spore-mass deep brown; spores pyriform, adherent as in *B. capsulifera* and about the same size, 10–12.5  $\mu$ , but even more strongly warted or echinulate on the exposed sides.

Distinguished by its short, dark stipe and adherent spores.

Not common. New England to South Carolina, Alabama, Wisconsin and Iowa; Rumania, Japan.

### 4. BADHAMIA CAPSULIFERA (Bull.) Berk.

Trans. Linn. Soc. 21 : 153. 1852.

Pl. II, Figs. 20, 21.

1791. *Sphaerocarpus capsulifer* Bull., Champ. 139.

1801. *Physarum hyalinum* Pers., Syn. Meth. Fung. 170.

1805. *Trichia capsulifera* (Bull.) DC., Fl. Fr. 2 : 254.

1826. *Physarum capsuliferum* (Bull.) Chev., Fl. Par. 330.

1827. *Physarum botryoides* var. *hyalinum* Fr., Stirp. Femsj. 83.

1852. *Badhamia hyalina* (Pers.) Berk., Trans. Linn. Soc. 21 : 153.

1892. *Badhamia varia* Mass., Mon. 319, in part.

Sporangia clustered or gregarious, sessile or sometimes stipitate, globose or obovoid, gray or greenish white, snow-white when empty;

peridium thin, translucent; stipe, when present, as in *B. utricularis*, although generally shorter and better developed, yellow or straw colored; capillitium a very loose, open network of white, lime-filled tubules, not much expanded at the nodes; columella none; spore-mass purplish brown; spores adhering in clusters of five or six to twenty or more, globose, but affected somewhat by mutual pressure, warted, delicately where attached, more distinctly on the exposed surfaces, 10–12  $\mu$ . Plasmodium white to chrome yellow.

This includes *Badhamia hyalina* (Pers.) Berk., regarded by Rostafinski as distinct, but the latter admits that the two species, as he defined them, are very much alike, having "the same spores and capillitium," differing in the form of the sporangium, an inconstant feature. Bulliard's name has precedence; his descriptions of this and of *B. utricularis* are remarkable.

The adherent spores distinguish the species from *B. utricularis*; and the sporangia sessile or with short but strand-like stipes, distinguish it from *B. papaveracea*. The plasmodia are small and hence the resulting clusters of sporangia are of limited extent as compared with a species such as *B. utricularis* which often fruits over a wide area.

The description as given applies to the typical European form. Collections from Iowa and Colorado are white, aggregate, superimposed, but have the capillitium and spores exactly as described for the type. They approach *B. populina* as it occurs in Colorado and hence the latter species has for years been referred to the Berkeley species. The thicker and more strongly calcareous peridia constitute, as would appear, the principal difference in the forms from Colorado. Such differences are no doubt largely due to the drier meteorological conditions of the western Mississippi valley; the climate is semi-arid as compared with that of western Europe. Eastern Europe, on the other hand, in its glacial history and meteorology, offers greater similarities, as is brought out in Brandza's discussion (1929), and these similarities are reflected in the striking similarity of the Myxomycete population of the two regions.

Iowa, Colorado; Europe, Australia.

Var. *repens* G. List., Essex Nat. 18 : 319, 1918, characterized by slender, curved plasmodiocarps, occurs in Rumania and Japan.

Var. *arborea* G. List., Mycetozoa ed. 3. 10, 1925, with small scattered sporangia, 0.3–0.5 mm., and spores pale purplish gray, globose or oval, 13–16  $\mu$ , is reported from Scotland.

Var. *major* Brandza, Bull. Soc. Myc. Fr. 44 : 252, 1929, is described as sessile or with a short membranous stalk, the capillitium scanty or lacking and the spores mostly free. Rumania.

5. *BADHAMIA POPULINA* Lister

Jour. Bot. 42 : 129. 1904.

Pl. I, Fig. 15.

Sporangia white, sometimes pale rose, subglobose or ovoid, smooth, calcareous, about 1.5 mm. in diameter, sessile and crowded, or rarely solitary on short yellow-brown membranous stipes; capillitial strands broad, calcareous; spores clustered, 16–20 or more in a cluster, purple-brown, warted unequally, one side coarsely, the other faintly, and usually marked by ridges and bands, 10–12  $\mu$ . Plasmodium said to be white or cream colored.

Generally distinguishable by its unusually large, calcareous, white or faintly rose colored sporangia. The peridial walls are shell-like in texture. Very near *B. capsulifera*, but larger, the sporangia more densely heaped and more calcareous and often with banded spores. Collections from Colorado referred to this species are very near to Iowa collections referred to *B. capsulifera*.

Colorado, Montana, Washington; Europe.

6. *BADHAMIA UTRICULARIS* (Bull.) Berk.

Trans. Linn. Soc. 21 : 153. 1852.

Pl. II, Figs. 22, 23.

1791. *Sphaerocarpus utricularis* Bull., Champ. 128.1797. *Trichia cærulea* Trentep., in Roth, Cat. Bot. 1 : 229.1803. *Physarum ovoideum* Schum., Enum. Pl. Scell. 2 : 198.1805. *Physarum hyalinum* var. *chalybæum* Alb. & Schw., Consp. Fung. 92.1805. *Trichia utricularis* (Bull.) DC., Fl. France 2 : 251.1821. *Trichia rubiformis* Purt., non Persoon, in Brit. Pl. of Midl. Count. 3 : 291.1825. *Physarum botryoides* Fr., Stirp. Femsj. 83.1826. *Physarum utriculare* (Bull.) Chev., Fl. Paris 1 : 337.1826. *Physarum botrytes* Somm., Fl. Lapp. 242.1832. *Diderma papaverinum* Wallr., Fl. Crypt. Germ. 375.1892. *Badhamia varia* Masee, Mon. 319, in part.

Sporangia clustered, spherical, ovoid or pyriform, large, 0.7–1.0 mm. in diameter, sessile or mounted on long, thin, strand-like stalks, blue-gray, violet-iridescent or cinereous, smooth or more often rugulose; peridium iridescent, hyaline or white when empty; stipes when present poorly differentiated, thread-like filaments as if representing strands of the plasmodium, often branched and usually reclining or even prostrate; hypothallus none; capillitium a large-meshed open network of rather slender tubules, the nodes unequally developed, white with the enclosed lime; spores nearly free although not without some

tendency to stick together, uniformly and distinctly warted, bright violet-brown, 10–12  $\mu$ .

This species resembles *B. capsulifera*, but is distinguished by a more strongly rugulose, less calcareous peridium and a more profuse development of filamentous stipes, but especially by the character of the spores. The spores of the present species while inclined, when mounted in a liquid, to stay together, only occasionally occur in regular clusters, nor do they show any differentiation in the episporic markings, these being uniform over the entire spore.

This is one of the finest and perhaps the most beautiful species of this fine genus, the plasmodium being very large and resulting in extensive areas of fructification. It is a forest species, generally to be found on trunks of fallen *Populus* or *Tilia* where the fine soft gray colonies often spread for several inches along the ridges and in crevices of the bark. Often on fungi and sometimes on lichens.

Washington, Montana, Colorado, Mississippi valley and east, Bolivia; Europe, South Africa, Australia.

#### 7. BADHAMIA MAGNA Peck

Rept. N. Y. State Mus. 31 : 57. 1879.

Pl. II, Figs. 24, 25, 26.

1872. *Dictydium magnum* Peck, Rept. N. Y. State Museum 24 : 84.

1892. *Badhamia varia* Masee, Mon. 319, in part.

1899. *Badhamia capsulifera* (Bull.) Berk. ex Macbride, N. A. Slime-Moulds 68, in part.

Sporangia globose or ellipsoid, 0.7–1 mm., bluish gray, iridescent, stipitate; peridium thin with slight calcareous deposits, rugulose, opening irregularly, white; stipe long, flaccid, straw colored; capillitium an elegant uniform net, its threads stiffened by slight deposits of lime, the nodes little thickened; spores free, dusky with a shade of violet, finely warted or spinulose, spherical, 11–12  $\mu$ , or oval, 14–15  $\times$  11–12  $\mu$ .

Closely resembling some forms of *B. utricularis*, from which it may be distinguished by its unclustered and smoother spores and its long, slender, pale stipes. *B. foliicola*, as here recognized, is very close, but smaller and with short stems. The spores from the type collection, Center, N. Y. (not Vermont, N. Y., as cited by Lister), are distinctly oval, and large, 14–15  $\times$  11–12  $\mu$ , with a prominent pale umbo at one end, probably indicating the area of dehiscence. Other collections referred here have spherical or nearly spherical spores.

The eastern United States and Canada; Rumania. Not rare. In the eastern United States it seems to occupy much the same place that *B. capsulifera* does in Europe.



8. *BADHAMIA OVISPORA* *Racib.*

Rozpr. Mat.-Przyr. Akad. Krak. 12 : 72. 1884.

Pl. II, Fig. 33.

Sporangia minute, 0.5 mm. in diameter or less, sessile, depressed-globose or plasmodiocarpous, white or ochraceous, sometimes on a dark red hypothallus; sporangium wall thick, calcareous, often scaly; capillitium white, often denser at the center to form a pseudocolumella; spores free, pale purple-brown, elongate, ellipsoidal or irregular,  $10-15 \times 8-10 \mu$ .

On old straw, dead wood, rabbit dung, etc. Not common. Pennsylvania, Massachusetts; Europe.

9. *BADHAMIA DECIPIENS* (*Curtis*) *Berk.*

Grev. 2 : 66. 1873.

Pl. II, Figs. 27, 28.

1848. *Physarum decipiens* Curtis, Am. Jour. Sc. II. 6 : 352.1873. *Physarum chrysotrichum* Berk. & Curtis, Grev. 2 : 66.1876. *Badhamia chrysotricha* (Berk. & Curtis) Rost., Mon. App. 4.

Sporangia gregarious, depressed-spherical or ovate, sessile, occasionally plasmodiocarpous, dull yellow, roughened by the rather numerous calcareous scales; columella none; capillitium dull orange, strongly calcareous, only slightly widened at the nodes, sometimes somewhat physaroid; spore-mass black; spores free, pale violet, very minutely spinulose,  $10-12 \mu$ . Plasmodium yellow.

Among free-spored badhamias this and the next species are at once distinguished by the color and the globose spores. If the original description can be regarded as defining anything, this is the same as *Physarum chrysotrichum* B. & C. It resembles somewhat *Physarum serpula* Morg., but differs externally in color and in the surface scales, which are not perceptible in the *Physarum*. The present species also resembles *Cienkowskia reticulata* (A. & S.) Rost., but has a different capillitium. See under that species.

According to Brandza (1929), when development occurs under moist conditions the colors are paler and the capillitium distinctly badhamioid, while under dry conditions the color becomes orange-yellow and the capillitium more or less physaroid.

Chiefly eastern and American. New England, Pennsylvania, Ohio, South Carolina, Bolivia; reported also from western Europe and Rumania.

10. *BADHAMIA VIRIDESCENS* *Meylan*

Bull. Soc. Vaud. Sc. Nat. 53 : 452. 1921.

Sporangia scattered or loosely clustered, stalked, subglobose, 0.5-0.8 mm. in diameter, yellow-green or gray with a yellow or red-

dish base, rugulose; sporangium well spotted and veined with lime granules, thicker and orange-yellow near the base; stalk yellow or yellowish red, sulcate, free from refuse deposits, 0.1–0.3 mm. high; capillitium a network of tubes enclosing pale yellow or white lime granules, with a few hyaline connecting threads; spores pale brownish violet, very minutely warted, 10–13  $\mu$ .

According to the author, partly or completely limeless forms may occur.

Scotland, Switzerland.

#### 11. *BADHAMIA AFFINIS* Rost.

Mon. 143. 1875.

Pl. II, Fig. 34.

Sporangia aggregated, often caespitose, discoidal to subspherical, sessile or short-stipitate, flat or umbilicate below, about 0.5–0.8 mm. in diameter; wall grayish white, rugulose and more or less calcareous and scaly; the stalk, when present, erect or sometimes nodding, 0.1 to 0.7 mm. tall, black or brownish black; hypothallus scanty, columella lacking; capillitium not abundant, white, the nodes somewhat expanded; spores globose, minutely but densely spinulose, violet-brown, averaging 16–17  $\mu$  in diameter. Lister cites the spore measurements as 10–15  $\mu$ ; Schintz as 12–15  $\mu$ . Material collected by Morgan in Ohio, and otherwise typical, has spores 16.5–18.5  $\mu$  in diameter.

Chiefly on moss, the small, pale, ashen sporangia appearing on the tips of the leaves. Specimens from Kansas, here referred, have pale, rugose stipes, about twice the height of the sporangium.

Not common, but cosmopolitan. Reported from New York, Ohio, Kansas, South America; Europe, Asia, South Africa.

#### 12. *BADHAMIA ORBICULATA* Rex

Proc. Acad. Nat. Sc. Phila. 1893 : 372.

Pl. II, Figs. 29, 30.

1894. *Badhamia macrocarpa* (Ces.) Rost. ex Lister, Mycetozoa 33, in part.

1925. *Badhamia affinis* Rost. var. *orbiculata* G. List., Mycetozoa ed. 3. 16.

Sporangia stipitate or sessile, orbicular, discoidal, irregularly elongated or plasmodiocarpous, averaging about 1 mm. in width, generally stipitate, and when stipitate, flattened or depressed above, plane or slightly umbilicate below; peridium simple, more or less translucent from the varying number of innate granules, sometimes covered with circular flat masses of lime, gray except the point of attachment to the stipe, which is brown; stipe short, black, rough, plicate; capillitium

dense at the center, radiant at the periphery where it meets the sporangial wall, white; spores violaceous black, minutely warted, 12–14  $\mu$ . Plasmodium cream to pale yellow.

This is a beautiful species, easily known by its discoidal or almost annulate sporangia mounted upon short, dark stipes. The stipe in western collections is sometimes very short, but generally suffices to raise the sporangium, a little at least, above the substratum. Sessile and plasmodiocarpous forms do occur with the typical stipitate phase, but may be regarded here as elsewhere as indicative of incomplete development. Miss Lister regards this as a variety of *B. affinis*, to which species it undoubtedly is related. But its larger size, somewhat smaller spores and slight but apparently constant differences in peridium and capillitium seem to justify its retention as a distinct species.

Pennsylvania, Ohio, Iowa, Nebraska, South Dakota, Colorado, Antigua; Malay Peninsula, Manchuria, Japan.

13. *BADHAMIA MACROCARPA* (Ces.) Rost.

Mon. 143. 1875.

Pl. II, Figs. 31, 32.

1855. *Physarum macrocarpon* Cesati, Flora 38 : 271.

Sporangia scattered, closely aggregate or crowded, globose or subglobose, 0.5–1.0 mm. in diameter, sessile or with a pale yellowish or brownish furrowed or submembranaceous stalk; peridium rugulose, white above, below yellowish or brownish; capillitium not abundant, thoroughly calcareous, the nodes broad, conspicuous, the connecting tubules rigid; columella none; hypothallus scant or none; spore-mass black, spores non-adherent, by transmitted light dark violet-brown, finely but densely and somewhat irregularly spinulose all over, spherical, 11–14  $\mu$ .

Externally closely resembling *B. panicea*, but easily distinguished by the larger, more spinulose spores. European authors describe both sessile and stipitate forms. American specimens generally are sessile and for the most part closely crowded, almost heaped. Professor Bethel has reported this in winter everywhere on fallen rotting stems of *Opuntia* and on the bases of dead *Yucca* leaves, still attached. Occasionally associated with the typical phase and often occurring alone was a discoidal form which when first seen (in 1908) was called var. *gracilis*, under which name Miss Lister distinguishes it. Further study suggests that the latter is best regarded as a distinct species, as it differs not only in its external characters but in its spores, which in *gracilis* are not only warted, but possess a coarse reticulation in addi-

tion. There is no evidence, in the abundant material at hand, that the two forms, although perhaps sometimes associated, arise from the same plasmodium.

*Badhamia mandshurica* Skvortz., Phil. Jour. Sc. 46 : 86, 1931, refers, perhaps, to a small, dark, heaped phase of *B. macrocarpa*.

Throughout the United States, Bolivia; Europe, Java, Japan.

14. *BADHAMIA GRACILIS* Macbride n. sp.

Pl. III, Figs. 37, 38.

1913. *Badhamia macrocarpa* Rost. ex Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 438, in part.

1922. *Badhamia macrocarpa* (Ces.) Rost. var. *gracilis* Macbr., N. A. Slime-Moulds ed. 2. 37.

Sporangia gregarious or clustered, globose or ovate, 0.5–0.7 mm. in diameter, stipitate or sessile, gray when filled with spores; peridium thin, pure white, sparsely flecked with white calcareous nodules; stipe when present thin, delicate, straw yellow, sulcate, more or less twisted, about equal to the sporangium; capillitium a delicate meshwork of tubules of nearly uniform diameter; hypothallus scanty, pale yellowish; spores free, globose or somewhat angular, dark violaceous brown, closely and irregularly warted, and mostly with a very coarse network of about 1–6 meshes to the hemisphere covering the surface, 12–15  $\mu$ .

The combination of close warts and coarse reticulum on the spore wall is distinctive, although suggested by the spores of *B. populina*, *B. cinerascens* and *B. lilacina*. Most of our material is on *Yucca* or cactus; the Iowa collection on bark.

Iowa, Colorado, New Mexico, Arizona, California and the West Indies.

15. *BADHAMIA CINERASCENS* Martin

Jour. Wash. Acad. Sc. 22 : 88. 1932.

Pl. III, Fig. 44.

Sporangia globose or flattened, sessile or occasionally borne on a pallid, membranous stipe, 0.7–1.5 mm. in diameter, densely aggregated and more or less superimposed, on a pallid membranous hypothallus; peridium thin, fragile, ashy, covered by a dense network of calcareous thickenings; capillitium abundant, white, badhamioid under lens, but under the microscope exhibiting numerous thread-like tubules; spores intensely black in mass, spherical or somewhat angular, non-adherent, deep purple-brown by transmitted light, densely and strongly spinulose, and often exhibiting an imperfect, coarse reticulation, always with



a paler area of dehiscence, 12–15  $\mu$ , averaging 13.5  $\mu$  of which 2  $\mu$  represents the spiny margin.

Close to *B. macrocarpa* and *B. gracilis*, and like these and related species with a more or less physaroid capillitium, but distinguished by its ashy color, the heaped sporangia and the extremely dark, coarsely and densely spiny spores. In appearance not unlike some specimens of *Physarum cinereum*, but the capillitium distinctly more badhamioid than physaroid, and the spores much larger, darker and rougher.

Colombia.

# 16. BADHAMIA PANICEA (Fr.) Rost.

ex Fuckel, Symb. Myc. Nachtr. 71. 1873.  
Pl. III, Figs. 35, 36.

1829. *Physarum paniceum* Fries, Syst. Myc. 3 : 141.

1847. *Reticularia schmitzii* Debey, Verh. nat. Ver. preuss. Rheinl. 1 : 1.

1873. *Badhamia verna* (Somm.) Rost. ex Fuck., Symb. Myc. Nachtr. 145, in part.

Sporangia white or cinereous, gregarious, or aggregated in closely compact clusters, globose or hemispherical, 0.4–1.2 mm. in diameter, sessile; hypothallus scanty, inconspicuous, very dark red, rarely with a short, red stalk; peridium thin, thickly dotted with white calcareous scales; columella none, although a pseudocolumella often appears, formed by a more dense development of the capillitium near the center of the lower part of the sporangium; capillitium abundantly developed, quite uniformly thickened, but showing an occasional delicate connecting thread, the nodes also somewhat flattened and enlarged; spore-mass black; spores free, by transmitted light bright violaceous brown, minutely punctate, 11–13  $\mu$ . The plasmodium is said to be white. Miss Lister separates forms having spores which are dark on one side and paler on the other as var. *heterospora*.

In America this seems to be mainly a western species. Specimens are before us from western Iowa and from Colorado, South Dakota, Nevada, Oregon, southern California and Europe. It is very well marked, though liable perhaps to be mistaken at first sight for sessile phases of *Physarum notabile* or *P. cinereum*. The capillitium is, however, at once determinative. In addition to the states mentioned, reported from Washington, Bolivia, Argentina.

Var. *nivalis* Meylan is reported as occurring at the margin of snow banks in Switzerland.

*B. goniospora* Meylan, Bull. Soc. Vaud. Sc. Nat. 56 : 66, 1925, lacks a hypothallus and has larger, somewhat irregular spores. It is

said to differ from *B. panicea* in the color of the plasmodium, and the larger, darker, more irregular spores, and from *B. foliicola* in the spore characters and the whitish gray sporangia.

17. *BADHAMIA FOLIICOLA* List.

Jour. Bot. 35 : 209. 1897.

Sporangia 0.5–0.6 mm. in diameter, subglobose or ellipsoidal, iridescent-gray, stipitate or sessile; peridium thin, rugulose, sparingly calcareous, when empty white; stipe when present short, yellowish, flaccid; capillitium badhamioid; spores free, delicately spinulose, dusky violaceous, 11–12  $\mu$ . Plasmodium orange.

If *Badhamia microcarpa* Schroet., Krypt. Fl. Schles. 3 (1) : 131, 1886, should prove to be the same, as is suggested by Lister and Schinz, that name would take precedence. Mr. Hagelstein reports the species as common on Long Island. The color of the plasmodium, quoted from Miss Lister, is of importance only when constant and confirmed by other criteria.

Meylan, Bull. Soc. Vaud. Sc. Nat. 57 : 301, 1931, reports a yellowish phase from Switzerland which he calls form *flavescens*.

New York, Ontario, Iowa, Oregon; Europe, Australia.

18. *BADHAMIA ALPINA* G. List.

Jour. Bot. 52 : 99. 1914.

Sporangia scattered or clustered, sessile, subglobose or hemispherical on a broad base, 0.5 to 0.9 mm. in diameter, gray or iridescent, usually seated on a dark hypothallus; capillitium a close network of slender tubes enclosing scanty deposits of lime; spores free, grayish lilac, almost smooth or very minutely warted, 10–12  $\mu$ . Plasmodium pale yellow or yellowish white.

This description is from Lister. Close to *B. foliicola*, differing in pale color of plasmodium, more hemispherical sporangia and paler, smoother spores.

Known from the Alps and Sweden. Not yet reported from North America.

19. *BADHAMIA LILACINA* (Fr.) Rost.

Mon. 145. 1875.

Pl. III, Figs. 39, 40.

1829. *Physarum lilacinum* Fr., Syst. Myc. 3 : 141.

1892. *Craterium lilacinum* Masee, Mon. 271.

1892. *Physarum concinnum* Masee, Mon. 308.



Sporangia globose, subglobose or obconical, sessile, gregarious or more or less clustered, supported by a thin, continuous transparent hypothallus; peridium smooth, pale lilac-brown or almost white without, paler or white within; stipe none, although some sporangia have a narrowed base; columella none, the pseudocolumella formed by a more densely aggregated capillitium near the base; capillitium dense, white, strongly nodulose; spore-mass black; spores free, dark, violaceous brown by transmitted light, covered with rough warts and ridges, sometimes subreticulate, 10–15  $\mu$ .

Easily recognizable, generally at sight, by its peculiar color. White forms, however, occur; often lilac-tinted and white from the same plasmodium. A perfectly white colony seems to be rare. Both colors are shown in specimens distributed. Whatever the color, the spores are in every case positively diagnostic. The episporic markings are unlike those of any other species in the genus. Rex described some New York forms as provided with a short but distinct stipe. Such forms bear a superficial resemblance to pale forms of *B. rubiginosa*. The hypothallus also is unique.

Common eastward. New England to Pennsylvania, Ontario, Ohio. Not reported west of the Mississippi. Also Europe, where it seems to be less common.

## 20. BADHAMIA RUBIGINOSA (Chev.) Rost.

Mon. App. 5. 1876.

Pl. III, Figs. 41, 42, 43.

1826. *Physarum rubiginosum* Chev., Fl. Par. 338, non Fr. 1817.

1874. *Craterium obovatum* Peck, Rept. N. Y. State Mus. 26 : 75.

1875. *Scyphium rubiginosum* (Chev.) Rost., Mon. 148.

1892. *Craterium rubiginosum* Massee, Mon. 270.

Sporangia gregarious, obovoid, grayish brown, stipitate; peridium simple, membranous, above thin, pale, more or less calcareous, below more persistent, blending with the stipe; stipe erect, reddish brown or purplish, expanded below into a small hypothallus, above prolonged within the sporangium more than half its height as a definite columella; capillitium very dense, snow-white, long-persistent with the lower two-thirds of the sporangial wall; spore-mass dark brown; spores by transmitted light dark violet or purple-brown, distinctly warted, not adherent, 12–14  $\mu$ .

This is probably the most common badhamia in North America. It is found on masses of decaying leaves, especially those of various species of oak. The plasmodium is yellow. The fructifications are very distinct, not likely to be mistaken for those of any other species;

the stipes constitute a very prominent feature in every gathering in our collection. Sometimes these are more or less coalescent, especially toward the base, where they are apt to be also wrinkled or longitudinally striate; in other specimens the stipes are well differentiated, long, terete, with little or no hypothallus.

*Badhamia curtisii* (Berk.) Rost. is according to Lister a sessile phase of this species. The only specimens known are in the herbarium of Berkeley, now at Kew. The species is based upon a gathering from South Carolina. Berkeley thought it a didymium and called it *D. curtisii*, Massee regarded it as a craterium.

*Badhamia dictyospora* Rost., Mon. App. 4, 1876 (*Craterium dictyospermum* Massee, Mon. 270, 1892), with obovoid sporangia, and spores coarsely warted or subreticulate, is reduced to varietal rank by Lister.

Var. *globosa* Lister, Jour. Bot. 42 : 130, 1904, is described as having subglobose, stipitate sporangia, dark columella and strongly reticulate spores. A collection from North Wales, so determined by Dr. Elliott, has as many obovate as globose sporangia, but the large, dark spores are beautifully reticulate.

Abundant in the forested regions of North America, especially in the Mississippi valley. Also western Europe, Poland and Rumania. The varieties not reported from North America, but recorded from Europe, Japan, South Africa, Hawaii.

## 21. BADHAMIA SUBAQUILA *Macbr.*

N. A. Slime-Moulds 64. 1899.

Sporangia closely gregarious or crowded, globose or subglobose, sessile, brown; peridium a thin but persistent brown membrane, rupturing above irregularly and remaining as a cup after spore dispersal; hypothallus none; capillitium strongly developed, thoroughly calcareous, the meshes large, the nodular thickenings broad, white; spores globose, in mass black, by transmitted light brown, very rough-warted, large, 15-18  $\mu$ .

The species is founded on material sent from Maine by the late Mr. F. L. Harvey. Professor Harvey, upon the authority of Morgan, cites the species (Bull. Tor. Bot. Club, 24 : 67) as *B. verna* (Somm.) Rost. But the specimens certainly do not conform to the description of *B. verna*. The wall corresponds with that of *B. rubiginosa*; but the spores are much larger, and the capillitial structure very different.

Miss Lister regards this as a form of *B. rubiginosa*. So far, the original gathering represents the species; but the woods of Maine are certain one day to send added information.

Maine. Rare.

### 3. *Erionema* Penzig

Myx. Buitenzorg 36. 1898.

Sporangia plasmodiocarpous, cylindrical, simple or branched; capillitium a network of slender colorless threads, *elastic*; nodules few and small.

#### ERIONEMA AUREUM *Penzig*

Myx. Buitenzorg 37. 1898.

Sporangia elongate, clustered, pendulous, yellow or grayish yellow, generally stipitate on long flaccid stalks, or sessile and interlacing; stipes yellow, blending with the hypothallus; capillitium intricate, expanding at maturity after the manner of *Arcyria* to several times the sporangial length, the nodules small, yellow; spores nearly smooth, violaceous brown, 5–6  $\mu$ .

This unique form is near the *fuligos*, which it closely resembles, especially when sessile. The spores also are much like those of the common *Fuligo septica*. The habit is, however, entirely different. Petch described clusters in Ceylon, hanging free, four to six cm. in length!

Known only from Japan, Java, Malay Peninsula and Ceylon.

### 4. *Physarum* Persoon emend. Rost.

Mon. 93. 1875.

1794. *Physarum* Pers., Roemer N. Mag. Bot. 1 : 88, in part.

Sporangia distinct or plasmodiocarpous, rarely almost aethalioid; peridium usually simple, sometimes double, irregularly dehiscent, more or less calcareous; capillitium in the form of a uniform but irregular network of calcareous nodules connected by hyaline thread-like tubules, adherent on all sides to the peridial wall.

The distinctive characters are the structure of the capillitium and the irregular dehiscence. The peridium, sometimes almost limeless, is usually encrusted with lime, which is always amorphous, never crystalline. The sporangia may be sessile or stipitate; the stipe, when present, may be solid or hollow and charged with lime.

As first proposed by Persoon, the genus included diverse forms. He made its limits more definite in 1795 and 1801 and in 1829 Fries further delimited it and set aside certain species as constituting the genus *Tilmadoche*. Rostafinski altered Fries' arrangement, retaining both genera, but recent writers have been agreed that the separation is artificial and have discarded *Tilmadoche*. Rostafinski's treatment,

however, had certain advantages of convenience. One possible solution seems to be to treat the genus *Physarum* as a whole, but to segregate the species into two sections, *Euphysarum* and *Tilmadoche*.

In using the key, it should be borne in mind that a number of sessile species may be somewhat plasmodiocarpous in some collections, and that stipitate species may be sessile at times. For the purposes of the key, each species is placed under what is believed to be its more representative expression.

## KEY TO THE SPECIES OF PHYSARUM

- Capillitium irregularly reticulate; lime-knots various,  
typically large and irregular. . . . . I. Section EUPHYSARUM  
Capillitium regular, forked and radiating; lime-knots  
smaller, fusiform. . . . . II. Section TILMADOCHE

## I. EUPHYSARUM

- |   |                           |
|---|---------------------------|
| a. Fructification sessile, often plasmodiocarpous. . . . .  | b                         |
| a. Fructification sporangiate, stalked. . . . .   | l                         |
| b. Peridium single, or, if double, inner peridium very delicate and closely<br>attached to outer. . . . .       | c                         |
| b. Peridium plainly double. . . . .   | h                         |
| c. White or cinereous. . . . .  | d                         |
| c. Some shade of yellow or green. . . . .   | e                         |
| c. Orange-red, red or brown. . . . .  | f                         |
| c. Dark gray, dull violet, blue or iridescent. . . . .  | g                         |
| d. Peridium granular; spores sometimes oval. . . . .  | 1. <i>P. ovisporum</i>    |
| d. White or gray, calcareous; spores dark, rough, 9–12 $\mu$ . . . . .  | 2. <i>P. vernum</i>       |
| d. Cinereous; wall thin, delicate; spores bright lilac,<br>finely spinulose, 7–11 $\mu$ . . . . .               | 3. <i>P. cinereum</i>     |
| d. Sessile, but narrowed at base; lime forming a fine<br>reticulation over surface. . . . .                     | 4. <i>P. gilkeyanum</i>   |
| d. Sporangia depressed, annulate or umbilicate above,<br>rarely with short stalks; spores 12–15 $\mu$ . . . . . | 5. <i>P. megalosporum</i> |
| d. Gray, sometimes slightly bluish; peridium smooth;<br>spores pale, 6–8 $\mu$ . . . . .                        | 6. <i>P. sessile</i>      |
| e. Pale yellow to ochraceous; spores 10–13 $\mu$ . . . . .  | 7. <i>P. serpula</i>      |
| e. Bright yellow; spores 9–12 $\mu$ . . . . .   | 8. <i>P. aureum</i>       |
| e. Yellow or greenish yellow to green; spores 7–10 $\mu$ . . . . .  | 9. <i>P. virescens</i>    |
| f. Vermilion or scarlet; lime-knots rounded, yellow, often<br>with red centers. . . . .                         | 10. <i>P. lateritium</i>  |
| f. Rusty or reddish brown; lime-knots angular, dull red<br>or yellowish. . . . .                                | 11. <i>P. rubiginosum</i> |
| f. Tawny or clay colored; very small, crowded; spores<br>6–7 $\mu$ . . . . .                                    | 12. <i>P. digitatum</i>   |
| f. Brownish orange or chestnut; spores 10–12 $\mu$ . . . . .  | 13. <i>P. famintzini</i>  |
| g. Dull violet-brown; small, densely clustered and super-<br>imposed. . . . .                                   | 14. <i>P. confertum</i>   |
| g. Blue-gray, iridescent; lime in form of flat scales. . . . .  | 15. <i>P. lepidoides</i>  |



- g. Dull gray, somewhat iridescent; limeless. . . . . 16. *P. nudum*  
 h. Red. . . . . 16a. *P. nasuense*  
 h. White or pallid. . . . . i  
 h. Yellow or ochraceous. . . . . j  
 h. Some shade of brown. . . . . k  
 i. Laterally compressed, chalk white; spores subreticulate. . . . . 17. *P. echinosporum*  
 i. Laterally compressed, white or gray, sometimes yellowish; inner peridium colorless or pallid. . . . . 18. *P. bivalve*  
 i. Somewhat compressed or terete, white or pallid; inner peridium purplish. . . . . 19. *P. bitectum*  
 i. Hemispherical, rarely laterally compressed, snow-white; outer peridium diderma-like, remote. . . . . 20. *P. diderma*  
 j. Pale yellow to yellowish white; plasmodiocarpous; spores 9–14  $\mu$ . . . . . 21. *P. alpinum*  
 j. Ochraceous, sporangiate; peridial walls distant; spores 8–10  $\mu$ . . . . . 22. *P. conglomeratum*  
 j. Deep ochraceous to pallid; short-plasmodiocarpous to reniform, densely crowded; spores spinulose, 11–13  $\mu$ . . . . . 23. *P. contextum*  
 j. Ochraceous to pallid; usually sporangiate, not crowded; outer peridium breaking up into scales, inner peridium persistent below; spores warted, 11–13  $\mu$ . . . . . 24. *P. mortoni*  
 k. Sporangiate; sessile or short-stalked, rarely plasmodiocarpous; lower part remaining as a cup. . . . . 25. *P. brunneolum*  
 k. Usually plasmodiocarpous; pinkish brown or bronze. . . . . 26. *P. æneum*  
 k. Usually plasmodiocarpous; outer peridium yellow-brown, dehiscing by triangular lobes revealing the pure white inner surface. . . . . 27. *P. bogoriense*  
 l. Columella large, conspicuous. . . . . m  
 l. Columella small, conical, sometimes imperceptible. . . . . n  
 l. Columella lacking, pseudocolumella sometimes present. . . . . q  
 m. Columella long, slender, acuminate; sporangia ellipsoidal, greenish. . . . . 28. *P. penetrale*  
 m. Columella cylindrical; sporangia pink. . . . . 29. *P. puniceum*  
 m. Columella stout, cylindrical or clavate, sometimes reduced; sporangia globose, grayish white or pale brown. . . . . 30. *P. crateriforme*  
 m. Columella subglobose or clavate, yellow. . . . . 31. *P. listeri*  
 m. Columella white, conical, attaining one-third the height of the sporangium; stipe stout, yellowish. . . . . 32. *P. perfectum*  
 n. Sporangia pale bluish gray to white; nodes white or yellowish. . . . . 33. *P. globuliferum*  
 n. Sporangia ashy brown; nodes orange to brownish. . . . . 34. *P. murinum*  
 n. Sporangia yellow or orange. . . . . o  
 n. Sporangia lilac to purple or blue. . . . . p  
 o. Honey yellow; columella and stipe white, yellow or tawny; nodes white. . . . . 35. *P. melleum*  
 o. Bright yellow; columella and stipe yellow; nodes yellow. . . . . 36. *P. citrinum*  
 o. Yellow-orange to bronze tawny; stipe orange-red, darker at base. . . . . 37. *P. pulcherripes*  
 p. Sporangia and stalk deep purple-red; nodes small, purple. . . . . 38. *P. pulcherrimum*  
 p. Pale lilac to pale red, rarely blue. . . . . 39. *P. lilacinum*



- q. Sporangia with a conspicuous, white calcareous nucleus at center. . . . . r  
 q. Sporangia non-nucleate. . . . . s  
   r. Globose, white; peridium membranous, capillitium dense. . . . . 40. *P. nucleatum*  
   r. Gray or brown; capillitium delicate. . . . . 41. *P. wingatense*  
   r. Ovoid or cylindric, crowded; outer peridium white, calcareous, sometimes lacking; inner peridium lead colored; spores 12–15  $\mu$ . . . . . 42. *P. didermoides*  
   r. Lime mass often columella e; stalked, sessile or plasmodiocarpous; spores 7–10  $\mu$ . . . . . 43. *P. mutabile*  
   r. Sporangia multilobate, contorted. . . . . 44. *P. nicaraguense*  
   r. Discoidal or top-shaped, depressed or umbilicate above 45. *P. discoidale*  
 s. Sporangia not globose or lenticular. . . . . t  
 s. Sporangia globose, subglobose or lenticular. . . . . u  
   t. Sporangia white; thin, saucer-shaped. . . . . 46. *P. javanicum*  
   t. Sporangia white or ashy; laterally compressed, circular to reniform, sometimes sessile and almost plasmodiocarpous. . . . . 47. *P. compressum*  
   t. Sporangia pale purple; obovate or wedge-shaped; stipe pallid, weak, often flattened. . . . . 48. *P. straminipes*  
 u. Brilliant purple; short-stemmed, sometimes sessile. . . . . 49. *P. newtoni*  
 u. Rose-red; stipe exceeding sporangium. . . . . 50. *P. roseum*  
 u. Blue or bronze, iridescent, spotted with red or orange; stipe brilliant orange. . . . . 51. *P. psittacinum*  
 u. Gray, white or iridescent. . . . . v  
 u. Yellow or yellowish. . . . . w  
   v. Stipe snow-white, fragile; peridium didymium-like. . . . . 52. *P. leucopus*  
   v. Stipe pale fuscous to brown, stout, short, wrinkled; peridium white to bluish. . . . . 53. *P. leucophæum*  
   v. Stipe bright yellow; nodes small, yellow. . . . . 54. *P. maculatum*  
   v. Sporangia depressed-globose, stipitate or sessile, strongly calcareous; stipe dark, opaque, sometimes frosted with white granules. . . . . 55. *P. notabile*  
   v. Stipe long, slender, bright brown; sporangia nearly globose, rather small, 0.4–0.6 mm. . . . . 56. *P. pusillum*  
   v. Stipe shorter, robust, dark; sporangia larger, iridescent, with scanty lime deposits. . . . . 57. *P. tropicale*  
 w. Color dull; pale, ochraceous, fulvous to nearly black. . . . . x  
 w. Bright yellow. . . . . y  
   x. Dull yellow to dusky; minute; spores 7–9  $\mu$ . . . . . 58. *P. simplex*  
   x. Yellowish white to fulvous; stipe weak, often lacking; spores dark, rough, 12–15  $\mu$ . . . . . 59. *P. albescens*  
   x. Pale or deep ochraceous; spores violaceous, 10–12.5  $\mu$  60. *P. citrinellum*  
   x. Dingy yellow to brownish ochraceous, often obovate or cylindrical; stipe short. . . . . 61. *P. variabile*  
   x. Peridium membranous, ochraceous above, lower part and stipe with flesh tints. . . . . 62. *P. carneum*  
   x. Yellowish to sooty, often iridescent. . . . . 63. *P. flavicomum*  
   x. Sulphur-yellow to olive-yellow; nodes large, white. . . . . 64. *P. sulphureum*

- y. Golden yellow; capillitium yellow, badhamioid; stipe short or lacking. . . . . 65. *P. auriscalpium*  
 y. Pale yellow or straw colored, rarely gray; dehiscence petaloid; stipe slender; nodes small, rounded. . . . . 66. *P. tenerum*  
 y. Golden yellow; peridium thin; capillitium dense, yellow, the nodes few, small and angular. . . . . 67. *P. galbeum*  
 y. Peridium bright yellow, rough; nodes yellow, dense, connected by yellow or hyaline threads. . . . . 68. *P. oblatum*

## II. TILMADOCHÉ

- a. Plasmodiocarpous, almost æthalioid. . . . . 69. *P. gyrosum*  
 a. Sporangiate, stalked. . . . . b  
   b. Sporangia compound, gyrose. . . . . 70. *P. polycephalum*  
   b. Sporangia single. . . . . c  
 c. Spores reticulate; sporangia dull orange to brown. . . . . 71. *P. dictyospermum*  
 c. Spores not reticulate. . . . . d  
   d. Gray or white, nodding. . . . . 72. *P. nutans*  
   d. Yellow, greenish yellow or rusty orange; nodding. . . . . 73. *P. viride*  
   d. Iridescent-blue with pale yellow scales; usually erect on short stipe. . . . . 74. *P. bethelii*  
   d. Yellow, orange or iridescent; lenticular, often umbilicate; capillitium rigid, rod-like. . . . . 75. *P. rigidum*

1. *PHYSARUM OVISPORUM* G. Lister

Jour. Bot. 51 : 91. 1921.

Sporangia scattered, sessile, pulvinate or forming straight, curved or irregular plasmodiocarps, 0.5 to 0.8 mm. in diameter, white; sporangium wall minutely roughened with deposits of lime granules, often with smoother areas where the lime deposits are scanty; capillitium consisting of numerous white, rounded lime-knots, varying much in size, connected by short hyaline threads; spores rich purple-brown, minutely warted, either globose, 9–11  $\mu$ , or oval, 12–13  $\times$  10  $\mu$ , often with a pale smooth line of dehiscence. Plasmodium white.

The above description is based on that of Miss Lister. Specimens from Switzerland, collected and determined by Meylan, have globose spores 9  $\mu$  in diameter with no visible area of dehiscence, and closely resemble some forms of *P. cinereum*, differing only in the longer plasmodiocarps and the somewhat more limy wall.

England, Switzerland.

2. *PHYSARUM VERNUM* Somm. ex Fries

Syst. Myc. 3 : 146. 1829.

Pl. XXI, Fig. 559.

1875. *Physarum cinereum* (Batsch) Pers. ex Rost., Mon. 102, in part.

1875. *Badhamia verna* (Somm.) Rost., Mon. 145, in part.

Sporangia sessile, generally plasmodiocarpous, white, nearly smooth, 0.5–1 mm. in diameter; peridium firm, usually double, the inner

membranous layer closely applied to the limy outer coat, not scaly, but breaking irregularly; capillitium densely calcareous, the nodules angular, branching, sometimes united to form a pseudocolumella; spores dusky violaceous, rough, 9-12  $\mu$ . The plasmodium is said to be white.

Sommerfeldt's description, quoted by Fries, evidently concerned a less calcareous phase. Fries by his annotation relieves somewhat the reader's uncertainty. Rostafinski calls this a badhamia but describes a physarum, and the form has frequently been confused with *P. cinereum* from the days of de Bary until now. In the second edition of the Mycetoza, Lister clears the situation by transferring the species to Physarum, and calling attention to spore dimensions. From all connection with Badhamia, as representing *B. panicea*, it should, as would appear, be withdrawn once and for all.

Mainly an old-world species. Many of the American collections so referred are better regarded as forms of *P. cinereum* with large spores. The European material in our collection is more definitely plasmodiocarpous and seems to have a much firmer wall, even in the less calcareous forms referred to as var. *iridescens* Lister. Whether all large-spored collections from America should be referred to *P. cinereum* is doubtful, however. Our only American specimens were sent by Mr. Hagelstein from Long Island.

New York, Washington, Cuba; Europe, South Africa, Hawaii, Australia.

Var. *iridescens* G. Lister lacks the limy outer coat, and, in material furnished by Miss Lister, is less plasmodiocarpous. Europe.

### 3. PHYSARUM CINEREUM (Batsch) Pers.

Roemer N. Mag. Bot. 1 : 89. 1794.

Pl. III, Figs. 45, 46.

- 1786. *Lycoperdon cinereum* Batsch, Elench. Fung. Cont. 1. 249.
- 1809. *Physarum griseum* Link, Mag. Ges. Nat. Fr. Berl. 3 : 27.
- 1829. *Didymium cinereum* (Batsch) Fr., Syst. Myc. 3 : 126.
- 1829. *Physarum plumbeum* Fr., Syst. Myc. 3 : 142.
- 1845. *Didymium scrobiculatum* Berk., Hook. Lond. Jour. Bot. 4 : 66.
- 1875. *Physarum cinereum* (Batsch) Pers. ex Rost., Mon. 102, in part.
- 1892. *Physarum scrobiculatum* (Berk.) Masee, Mon. 300.

Sporangia sessile, closely gregarious or heaped, subglobose, elongate or plasmodiocarpous, more or less calcareous, lilaceous gray; peridium simple, thin, more or less densely coated with lime; capillitium strongly developed, the internodes more or less richly calcareous and badhamioid, the lime-knots rounded and angular; spore-mass purplish brown,

spores clear violaceous, distinctly warted, 7–11  $\mu$ . Plasmodium watery white or colorless.

This delicate species is well defined by the characters given. It occurs not rarely on richly manured ground, in forests, meadows, lawns or even on the open prairie. The plasmodium may form rings several inches in diameter, scattered here and there over a surface several square feet in extent, in fruit ascending the blades of grass, completely covering these with the crowded sporangia. The color of the fruit is well described in the specific name; gray or ashen gray. The spores are usually very distinctly papillate; in some specimens, however, almost smooth; in a few instances, rough.

The present species well illustrates the difficulty confronting the author of today who, discussing a group of microscopic organisms, would fain use the nomenclature of his predecessors, honored, but equipped with insufficient lenses. Here is a species reported common in Europe, observed by every mycologist there, from Micheli down, and yet awaiting adequate description until Rostafinski in his great book gives the results of microscopic analysis. We are now really dealing with *P. cinereum* Rost.; *P. cinereum* (Batsch) is a compliment to certain rather clever water-color drawings.

Rostafinski gives a long list of synonyms; none, it is believed, represent American forms; and without taking careful thought, surely no one would rudely disturb such honorable interment, but in his description the range of spore measurement, 7–13.3  $\mu$ , gives us pause, and raises the suspicion that possibly, in one case or another, the sepulture were perhaps premature. The range is too great! Perhaps, in the series offered in confirmation, small-spored forms represent one species, large-spored, something else. European students may decide this at their leisure. But Rostafinski having, not without much labor, practically completed his review of the physaroid forms, had almost finished the last genus *Badhamia*, when his mind perhaps returned, no doubt with some lingering misgivings, to the thirteenth species in his *Physarum* list. There were there, he recalled, some large-spored specimens which had rather badhamioid capillitium. The sessile physarums of Fries were also before him, those especially, "*floccis albis*." Of these one shall be *B. panicea*, one *B. lilacina* and one *B. verna*, described as having rather delicate colorless capillitial tubes combined in a loose net, the calcareous deposits about the enlarged intersections scanty, the spores 12.5  $\mu$ . The description of the fructification as a whole is a condensed statement of that which describes *P. vernum*, and all taken together indicates some physarum. See comment under *P. vernum*.



*P. plumbeum* Fr. belongs here. It has similar spores; the only difference is a less calcareous peridium and more scattered habit of fructification with more nearly regular, depressed-globose sporangia. *P. cinereum* Pers. as cited by Link (Mag. Ges. Nat. Fr. Berl. 3 : 27, 1809) is apparently a badhamia, but may be *P. vernum*, while *P. griseum* is probably the present species. Specimens collected by Wingate and distributed by Ellis and Everhart as N. A. F. 2085, should be referred to *Didymium melanospermum*.

Var. *scintillans* Brandza, Bull. Soc. Myc. Fr. 44 : 260, 1929, is described as having isolated metallic blue or bronze sporangia with few or no calcareous nodes. The bluish form is described as having spores 9–10  $\mu$ , the bronze, 12–14  $\mu$ . Its position must be regarded as uncertain.

Careful examination of a wide range of American collections suggests that the large-spored forms are not *P. vernum* and constitute a distinct variety of *P. cinereum*, perhaps a closely allied species.

Common and cosmopolitan.

#### 4. PHYSARUM GILKEYANUM Gilbert

Am. Jour. Bot. 19 : 133. 1932.

Sporangia gregarious, globose or clavate, sessile, but narrowed at the base, 0.4 to 0.8 mm. in diameter, 0.7 to 0.9 mm. tall; peridium hyaline, gray when without lime but usually covered with a thin even layer of grayish white lime, brittle, breaking irregularly, the inner surface rough, the lime covering forming a reticulation of thin wrinkles over the entire sporangium; capillitium of fine hyaline threads, a dense, rigid, fine-meshed net that retains the form of the sporangium after the peridium breaks away, the lime-knots white, few, in the upper part of the sporangium small and more or less rounded, in the base of the sporangium tending to be long branching and somewhat badhamioid with larger meshes in the capillitium; spores dark violet in mass, globose, warted, violet-brown under the lens, 9–11  $\mu$ .

Oregon. In leaf mold under deciduous trees and brush.

#### 5. PHYSARUM MEGALOSPORUM Macbride

N. A. Slime-Moulds ed. 2. 63. 1922.

1917. *Physarum melanospermum* Sturgis, Mycologia 9 : 323, non Pers.

Sporangia gregarious, sessile or short-stipitate, depressed, annulate, or at least umbilicate above, white, rarely roseate, 0.5–0.8 mm. in diameter; stipe, when present, short, thick, black or dark brown, hypothallus none; columella none, but capillitium sometimes massed toward the center; capillitium strongly calcareous, the delicate net bearing an abundance of irregular white nodules; spores dark pur-



plish brown with a lighter area of dehiscence, minutely verruculose, 11.5–14.8  $\mu$ .

This species is recognizable at once by its regular, uniform, depressed, annulate or pitted sporangia, scattered evenly over the habitat of rotten leaves or wood. In its form and habit it suggests a didymium.

Colorado.

#### 6. *PHYSARUM SESSILE* Brandza

Ann. Sc. Univ. Jassy 11 : 116. 1921.

1898. *Physarum variabile* Rex var. *sessile* List., Jour. Bot. 36 : 114, in part.

Sporangia solitary or gregarious, sessile, globose, 0.4–1 mm. in diameter or forming elongated, sinuous plasmodiocarps 2–10 mm. in length and 0.5–0.8 mm. broad, grayish, bluish gray or pale gray; peridium smooth, forming a fragile crust, formed by the aggregation of transparent, calcareous granules 1  $\mu$  in diameter; pseudocolumella globose, white; capillitium abundant, long-persistent, with rounded, subequal, calcareous nodes 15–25  $\mu$  in diameter, formed of masses of granules identical with those of the peridium, and which, like them, become dissociated in water; connecting threads scanty, hyaline; spores smooth, pale violaceous brown, 6–8  $\mu$ . Plasmodium grayish white.

As originally described this included both this species and *P. aureum*. In a later paper (1929), the author clearly distinguishes between the two species and the later description is here followed.

On dead leaves: West Indies; Rumania, Japan. The Lister monograph records the species from Canada, Venezuela, Switzerland and Ceylon. It is not certain whether the collections cited are this species or *P. aureum*.

#### 7. *PHYSARUM SERPULA* Morgan

Jour. Cin. Soc. Nat. Hist. 19 : 29. 1896.

Pl. III, Figs. 47, 48.

1892. *Physarum gyrosium* Rost. ex Massee, Mon. 307, in part.

1894. *Badhamia decipiens* (Curt.) Berk. ex Lister, Mycetozoa 32, in part.

Sporangia sessile, sometimes subglobose, usually forming plasmodiocarps in the form of lines, rings or a simple network, 0.3 mm. in diameter; yellow or ochraceous, fading; peridium thin, fragile, simple, membranaceous but persistent, borne on a rather widely effused hypothallus; capillitium of numerous yellow lime-knots connected by short and scanty hyaline threads; spores globose, violaceous by transmitted light, minutely warted, 10–13  $\mu$ . Plasmodium at maturity greenish yellow.

A very distinct species not likely to be confused with anything else. In description, so far as concerns external characters, it suggests *Cienkowskia reticulata*, but lacks the orange and red colors. The two forms are not at all alike when placed side by side. For details as to the difference, see the description of the species last mentioned.

In 1805, Albertini and Schweinitz (Consp. Fung. 90) described as *Physarum reticulatum* a European form which became the basis of Rostafinski's genus *Cienkowskia*. Later, in 1829, Schweinitz collected in America a physarum-like specimen which he took to be the same thing, and accordingly placed it in his herbarium under this name, and listed it in his 1832 paper as No. 2295. Rostafinski further renamed another Schweinitzian species, *Fuligo muscorum*, calling it (Mon. 111) *Physarum gyrosum*. Wingate and Rex apply in Ellis, N. A. F. 1396, this latter name to No. 2295 of Schweinitz. Such a reference is a mistake, judging from Rostafinski's descriptions and from the descriptions and figure of Albertini and Schweinitz (Consp. Fung. 86), and by the testimony of Lister.

Eastern United States to Iowa and Nebraska, not rare; Japan.

#### 8. PHYSARUM AUREUM *Brandza, non Pers.* 1794

Bull. Soc. Myc. Fr. 44 : 261. 1929.

Sporangia solitary or in small groups, sessile, 0.4–0.6 mm. in diameter or forming elongated, sinuous plasmodiocarps, 2–12 mm. long by 0.4–0.6 mm. wide, bright yellow; peridium rugulose, pelliculose, transparent yellow, encrusted with very minute yellow calcareous granules clustered in small groups; columella lacking; capillitium well developed, long-persistent, with firm, bright yellow calcareous nodes, angular and of unequal sizes, ranging from 10–25  $\mu$ , composed of very minute calcareous granules similar to those on the peridium and not breaking up in water; connecting threads numerous, hyaline, branched; spores pale violaceous brown, minutely echinulate, 9–12  $\mu$ . Plasmodium bright yellow.

South Carolina, New York; Rumania.

#### 9. PHYSARUM VIRESCENS *Ditmar*

in Sturm, Deutsch. Fl. Pilze 1 : 123. 1817.

Pl. III, Figs. 49, 50.

1818. *Physarum thejotum* Fr., Symb. Gast. 21.

1832. *Physarum caespitosum* Schw., Trans. Am. Phil. Soc. II. 4 : 258.

1873. *Didymium nectriæforme* Berk. & Curt., Grev. 2 : 65.

1876. *Physarum ditmari* Rost., Mon. App. 8.

1877. *Didymium sinapinum* Cooke, Myx. Gt. Brit. 33.

Sporangia small, 0.2–0.4 mm. in diameter, or rarely larger, sessile, often crowded or heaped in small bunches, a dozen or more sporangia in one pile, spherical, ovoid or elongate, yellow or greenish yellow or pallid gray-green; peridium thin, fragile; capillitium delicate, with rather small, irregular, yellowish, calcareous nodes; columella none; spores bright violet, minutely roughened, 7–10  $\mu$ .

This species occurs most commonly on moss-tufts, with which it is frequently concolorous, or escaped on dead leaves, etc. The peridium is flecked with calcareous scales or grains stained yellow or green, and to these the whole fruit owes its peculiar color. The color and aggregate, heaped sporangia are distinctive macroscopic characters.

In the Monograph, p. 103, Rostafinski properly adopted Ditmar's name for this species. Upon later consideration, in the Appendix, he changed the name, writing *P. ditmari*, on the ground that *virescens* was descriptive of a character to which it occasionally refuses to conform. Most authors since Rostafinski have simply accepted his suggestion, so that the species is often entered as *P. ditmari* Rost. *P. virescens* is certainly to be preferred.

Var. *obscurum* List. is greenish gray, larger, with spores 6–8  $\mu$ ; var. *nitens* List. is bright yellow or orange.

Widely distributed in Canada, the United States and Europe; also Java, Japan.

#### 10. PHYSARUM LATERITIUM (*Berk. & Rav.*) *Morg.*

Jour. Cin. Soc. Nat. Hist. 19 : 23. 1896.

1873. *Didymium lateritium* Berk. & Rav., Grev. 2 : 65.

1873. *Didymium croceoflavum* Berk. & Br., Jour. Linn. Soc. 14 : 84.

1876. *Physarum ditmari* var. *croceoflavum* Rost., Mon. App. 9.

1876. *Physarum ditmari* var. *lateritium* Rost., Mon. App. 9.

1879. *Physarum inaequale* Peck, Rept. N. Y. State Mus. 31 : 40.

1892. *Physarum chrysotrichum* Berk. & Curt. ex Massee, Mon. 300, in part.

Sporangia gregarious, sessile, globose, subglobose or plasmodiocarpous, yellowish or orange when fresh, spotted with minute scarlet granules; peridium thin, more or less rugulose; columella none; capillitium delicate, the colorless or yellow threads connecting the yellow nodules, these often with red centers; spores violet-brown in mass, by transmitted light pale violet, minutely roughened, 7–9  $\mu$ .

A well-marked species easily recognized by the characters cited. The extent of lime deposit at the capillitial nodes varies; it is sometimes very scanty. This accounts for Berkeley's generic reference. The capillitium in broken specimens soon fades, becoming pallid or whitish.

Nova Scotia and New York to Colorado and south, Brazil, Chile; Europe, Ceylon, Malay Peninsula, Java.

# 11. PHYSARUM RUBIGINOSUM *Fr.*

Symb. Gast. 21. 1817.

Pl. IV, Figs. 51, 52.

1825. *Leangium rubiginosum* Fr., Stirp. Femsj. 83.

1829. *Physarum fulvum* Fr., Syst. Myc. 3 : 143.

Sporangia globose or cylindric, sessile or sometimes narrowed to a stem-like base as if short-stipitate, 0.5–0.8 mm. in diameter, olivaceous brown to reddish brown or scarlet; peridium simple, thin, rugulose or plain, the calcareous scales few, or apparently included; columella none; capillitium dense, the nodules rather large, angular, rusty brown; spores dull violaceous, faintly warted, 9–11  $\mu$ . Plasmodium scarlet.

A beautiful, well-marked species, evidently rare in North America.

In the west there is a plasmodiocarpous form of the species. It has the characteristic spores and capillitium but in form and habit differs very decidedly. The fructification is a delicate netted plasmodiocarp, the tubule about 0.5 mm. broad, bright red; peridium simple, cartilaginous, dehiscent from above, and flecked with just here and there a red calcareous scale. A collection from Ontario (Dearness) has spores ranging from 11–12  $\mu$ , but probably belongs here.

New Hampshire, Ontario, Iowa, Colorado; Europe.

# 12. PHYSARUM DIGITATUM *Farquh. & G. List.*

Jour. Bot. 54 : 128. 1916.

Pl. IV, Figs. 53, 54.

1896. *Physarum thejoteum* Morgan, *non* Fr., Jour. Cin. Soc. Nat. Hist. 19 : 22.

1911. *Physarum virescens* Lister, *non* Ditmar, Mycetozoa ed. 2. 83.

1922. *Physarum instratum* Macbr., N. A. Slime-Moulds ed. 2. 62.

Sporangia subglobose, obovoid or cylindrical, very small, 0.1 to 0.3 mm. in diameter, closely crowded on a delicate hypothallus, often connate, but not superimposed; dull orange, brownish or tawny; peridium thin, covered with very minute, tawny calcareous scales; columella none; capillitium lax, often scanty, the nodules small, yellowish or brownish, occasionally confluent; spore-mass dull violaceous, spores pale violet, with clusters of minute warts scattered over the surface, 6–7  $\mu$ .

Not uncommon in the Mississippi valley, where it sometimes is passed by the collector as an immature form of some other species.



The appearance is very characteristic, unlike *P. virescens* in habit, size and color. Colonies are quite often three inches in length. The most common habitat seems to be rotten oak, especially fragments of charred logs, etc.

Ohio, Illinois, Iowa, Missouri, Nebraska; Nigeria, South Africa.

13. *PHYSARUM FAMINTZINI* Rost.

Mon. 107. 1875.

1898. *Physarum gulielmæ* Penzig, Myx. Buit. 34.

Sporangia sessile, subglobose or reniform, about 0.4 mm. in width, brownish orange or chestnut brown, rugulose, clustered or heaped, often with a yellow membranous hypothallus; peridium membranous, with clustered deposits of yellowish brown lime granules; capillitium abundant, the nodes angular, branching, white; spores purplish brown, spinulose, 10–12  $\mu$ . Plasmodium yellow or orange.

This is an old-world species. In the United States National Herbarium there is a scanty collection from Maryland (No. 15976), consisting of five sporangia, growing with *Didymium squamulosum*, which must be referred here. The hypothallus is brilliant orange, the spores purplish, 9–11  $\mu$ , averaging 9.5  $\mu$ , a little small for the species as described. In other respects the agreement is perfect.

Maryland; Europe, Java.

14. *PHYSARUM CONFERTUM* Macbr.

N. A. Slime-Moulds ed. 2. 64. 1922.

Pl. XXI, Fig. 560.

1896. *Physarum atrum* Schw. ex Morg., Jour. Cin. Soc. Nat. Hist. 19 : 27, non Schw.

Sporangia subglobose or somewhat elongate, sessile, small, 0.2–0.4 mm. in diameter, gregarious or confluent, often clustered or in heaps, dull violaceous brown; peridium thin, more or less transparent, nearly limeless, or reticulated or sprinkled with minute white flecks of lime; capillitium scanty, the nodes small, elongate, rounded, white; columella none, spores violet-brown, minutely warted, 10.5–12.5  $\mu$ . Plasmodium white or yellowish.

Following Morgan, this has frequently been referred to as *P. atrum* Schw. The latter species is now known to be a limeless form of *P. didermoides*. *P. reticulatum* Berl., in Saccardo, Syll. Fung. 7 : 350, 1888, non Alb. & Schw., is based on *P. atrum* Schw. The species has also been confused with *P. cinereum*, *P. plumbeum* and others, but it is in fact quite distinct, distinguished from everything else by the color and



small size of the heaped sporangia. It resembles some phases of *P. virescens* where the sporangia are small and somewhat heaped or rather aggregated, and scantily supplied with lime; but in such case the lime is yellow and the spores are small.

Not uncommon, especially eastward; occurring also in Europe.

#### 15. *PHYSARUM LEPIDOIDEUM Gilbert*

Am. Jour. Bot. 19 : 133. 1932.

Sporangia sessile, solitary or in small groups, on black waste matter forming a small hypothallus, irregularly globose, 0.5 to 1.2 mm. in diameter, with a tendency to form small crowded plasmodiocarps; peridium blue-gray, membranous, iridescent, with a thin layer of flat, more or less rounded lime-scales similar to those of *Lepidoderma*; capillitium a dense net of colorless threads, the lime-knots white, conspicuous but not abundant, medium sized, rounded or with points meeting the capillitial threads, a few sometimes larger and more angled; spores dark purple in mass, globose, under the lens bright violet, uniformly finely warted, 12–14  $\mu$  in diameter.

The *Lepidoderma*-like peridium is distinctive. The spores are larger than in most physarums and very uniform in size.

Oregon: on old kale stalks in a pile of herbaceous waste.

#### 16. *PHYSARUM NUDUM Macbride*

Am. Jour. Bot. 19 : 134. 1932.

Sporangia sessile, globose or somewhat plasmodiocarpous, occasionally with a pallid, slender, usually prostrate stipe, 0.4–0.7 mm. in width; peridium single, limeless, dark gray, somewhat iridescent; hypothallus scanty, reticulate, membranous, hyaline, connecting the lines of sporangia; columella none; capillitium sparse and nearly or quite limeless, composed of slender thread-like tubules here and there expanded into hyaline vesicular structures; spores violet-black in mass, clear violet under the lens, minutely roughened, 9.5–11  $\mu$  in diameter.

A specimen collected by T. H. Macbride in Washington in 1916, was marked as a new species under this name. Another specimen, collected by Mr. H. C. Gilbert in May, 1930, near Salem, Oregon, proved to be the same. In its limeless character it suggests *P. confertum*, but differs in size, color and habit of growth; it suggests also limeless forms of *P. didermoides* but is different in habit, and with smaller, lighter colored, much smoother spores. Mr. Gilbert notes that the sporangia

are milk-white when young, which would indicate a watery or white plasmodium. Apparently the plasmodium remains in the soft rotting wood, coming to the surface only at the time of fruiting.

Oregon, Washington.

16A. *PHYSARUM NASUENSE* *Emoto*

Bot. Mag. Tokyo 45 : 551. 1932.

Sporangia scattered or grouped, sessile, elliptical, short-pulvinate or branched, 0.35–0.5 mm. in width, Eugenia red \* or jasper red \*; wall double, the outer membrane cartilaginous, scarlet \*, the inner membrane pale yellow, thin, transparent, bearing small calcium granules, attached to the outer; hypothallus and columella lacking; capillitium of thin, pale yellow, transparent threads and concolorous nodules with deep red centers, the calcium granules of the nodes round, 1–3  $\mu$  in diameter, the nodules irregular, angular or round; spores globose, violet-brown, uniformly warted, 8–10  $\mu$ . Plasmodium orange-red.

Differing from *P. lateritium* in color, in regular dehiscence and in the double wall, and from *P. brunneolum* in shape, color and capillitial characters. In incompletely matured sporangia the wall is more calcareous and the dehiscence lobate. Non-calcareous sporangia occur which are dark brownish or dark violet-brown. We have seen no specimens.

Known only from Japan.

17. *PHYSARUM ECHINOSPORUM* *Lister*

Jour. Bot. 37 : 147. 1899.

Sporangia scattered, forming chalk-white, usually curved plasmodiocarps, strongly compressed laterally, dehiscing along the thin upper ridge; sporangium wall of two layers, the outer smooth, egg-shell-like, charged with minute lime granules, separating from the membranous iridescent pale purplish inner layer; capillitium of numerous smooth white lime-knots of irregular shapes and sizes, connected by short hyaline threads; spores purple, marked with strong ridges and spines, 8  $\mu$ .

The above description is based on Lister, 3rd ed. We have not seen authentic material. Obviously very close to *P. bivalve*, apparently the chief distinctions being the firmer, smoother, outer peridium and the very rough, ridged spores.

Known only from Antigua, West Indies.

\* An asterisk after a color term indicates that it is used in the sense of Ridgway: Color Standards and Nomenclature, 1912.

18. PHYSARUM BIVALVE *Pers.*

Ust. Ann. Bot. 15: 5. 1795.

Pl. IV, Figs. 57, 58, 59.

1791. *Reticularia sinuosa* Bull., Champ. 94.  
 1828. *Angioridium sinuosum* (Bull.) Grev., Scot. Crypt. Fl. 310.  
 1829. *Diderma valvatum* Fr., Syst. Myc. 3: 109.  
 1829. *Physarum sinuosum* (Bull.) Weinm. ex Fr., Syst. Myc. 3: 145, *non* Link.  
 1849. *Carcarina valvata* Fr., Summ. Veg. Scand. 451.  
 1869. *Diderma contortum* Fuck., Symb. Myc. 341.

Fructification plasmodiocarpous, the plasmodiocarp creeping in long vein-like reticulations or curves, laterally compressed, or sometimes sporangiate, distinct and crowded, sessile; peridium double, the outer layer thick, calcareous, fragile, snow-white to gray or yellowish, the inner delicate, colorless, the dehiscence by more or less regular longitudinal fissure; capillitium strongly developed with abundant white, calcareous granules; spores minutely spinulose, dull violet, 8–10  $\mu$ . Plasmodium reported as pale gray, or nearly white, but typical specimens are sometimes associated with a yellow plasmodium.

Easily recognized at sight by its peculiar form, bilabiate and sinuous. Except for its microscopic structure, perfectly described by Fries, Syst. Myc. 3: 145. Habitat various, but not infrequently the upper surface of the leaves of living plants, a few inches from the ground. Plasmodiocarpous and sporangiate fructifications often occur side by side, or merge into one another from the same plasmodium. Where the substratum affords room the plasmodiocarpous style prevails; in narrower limits single sporangia stand. The calcareous deposit on the peridium is usually very rich and under a lens appears made up of countless snowy or creamy flakes. Forms occur, however, in which these outer deposits are almost entirely wanting; the peridium becomes transparent, the capillitium visible from without. Judging from material before us, this appears to be the common presentation in western Europe. The degree of compression is very variable. Some collections show compressed plasmodiocarps opening by narrow fissure along their knife-edged summit, with scarce place for capillitium at all between the approaching walls; others take the form of colonies of sporangia almost terete, calcareous without, opening in fragmental fashion at the top, displaying sometimes the thin membranous inner wall, but at length fissured and gaping as in the more usual phase figured by various authors, where the plasmodiocarp is simply compressed but not extravagantly thin. Both types occur in the western mountains, forms with and without calcium, fissured by wider or narrower cleft, from the same plasmodium; forms bilabiate and forms opening at first to

display an inner peridium; forms globose with narrow base, but apex cleft, and forms ellipsoidal, yet compressed, opening like the gaping of some tiniest bivalve. Some of the shorter forms become obovate, the bases so constricted as almost to constitute stipes. Surely variation in the same plasmodium can go no farther!

Cosmopolitan. Widely distributed in the United States and often common. Frequent in Europe and reported from all continents except Australia. We have a collection, however, from Samoa.

#### 19. *PHYSARUM BITECTUM* List.

Mycetozoa ed. 2. 78. 1911.

Pl. IV, Figs. 55, 56.

1891. *Physarum diderma* List., Jour. Bot. 29 : 260, *non* Rost.

Sporangia gregarious, some subglobose and sessile, mostly plasmodiocarpous, smooth, white or pallid, terete or somewhat compressed; peridium double, the outer wall calcareous, free and deciduous above, recurved and persistent below, the inner smooth, pale purplish, more persistent; dehiscence more or less irregular beginning at the top; capillitium of large white nodules connected by short hyaline tubes; spores violaceous brown, spinulose, with a conspicuous smoother area, 10–12  $\mu$ .

Related to *P. bivalve*, but differing in the purplish inner wall, the larger, rougher spores, and the less compressed fructifications. The latter character is variable in both species.

Colorado and Montana to the Pacific coast, not rare, Venezuela; Europe, South Africa, Australia.

#### 20. *PHYSARUM DIDERMA* Rost.

Mon. 110. 1875.

Pl. IV, Figs. 60, 61.

1898. *Physarum didermoides* Rost. var. *lividum* Lister, Jour. Bot. 36 : 162.

1907. *Physarum testaceum* Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 18.

Sporangia snow-white, clustered, sessile or narrowly adnate, globose or polygonal by mutual compression; peridium double, the outer layer dense, fragile, thick, calcareous, the inner delicate, remote, translucent; capillitium well developed, the calcareous nodules white, rounded or angular, sometimes uniting to form a pseudocolumella; spore-mass black; spores purplish, distinctly rough, 10–12  $\mu$ .

A beautiful and distinct species. As others in the group with which



it is here associated, it is a physarum with the outer seeming of a diderma. It occurs in Europe, therefore it is safe to assume that Rostafinski saw it. So well marked it is that any good description will define it, and Rostafinski describes it perfectly, adequately.

Mr. Lister having used for another species the name we here apply—see under *P. bitectum*—referred this present form to *P. didermoides* Rost. Professor Sturgis, convinced that such reference was at least doubtful, gave to our American gatherings the distinctive name above, citing specimens from Massachusetts, from Colorado, and from California. Curiously enough he also includes specimens of *P. didermoides* var. *lividum* List., sent from England.

As stated, Mr. Lister first applied the name *P. diderma* to a plasmodiocarpous form occurring in England and near *P. bivalve*. Later, Mycetoza, 2nd ed., 78, he adopted a new specific name, *P. bitectum*, for the English specimens, and entered *P. diderma* as a probable synonym for *P. lividum* Rost. There is really no more merit in this later comparison than in that discarded. The species *P. diderma* is not *P. lividum*, but stands as originally delimited, and will, doubtless, again appear in Europe.

Rare. Certainly rare in Europe and so far seldom seen in the United States, though widely distributed. Specimens are before us from Maine, New York, Ohio, Michigan, Iowa, Oregon. Reported from Montana.

## 21. PHYSARUM ALPINUM G. List.

Jour. Bot. 48 : 73. 1910.

Pl. IV, Figs. 62, 63.

Sporangia globose and sessile, or plasmodiocarpous, dull yellow, smooth or scaly; peridium double, the outer wall densely calcareous, separating irregularly from the membranous inner wall; capillitium densely calcareous, the nodes large, more or less branched, yellow; spores purple-brown, closely and minutely warted, 9–14  $\mu$ .

This species is based by its author upon a gathering made in California by Dr. Harkness and named by Phillips, who received it in England, *Badhamia inaurata*. He seems not to have described it. Since its first appearance, the form has been found repeatedly in the Juras, whence Meylan reports pale yellow or whitish forms with, however, the typical yellow capillitium. Specimens from Mt. Rainier are believed to be the same. The more strongly marked plasmodiocarpous habit and yellow capillitium separate this from the related *P. contextum* and *P. mortoni*.

California, Washington; Europe.



22. *PHYSARUM CONGLOMERATUM* Rost.

Mon. 108. 1875.

1886. *Physarum ochraceum* Schroet., Krypt.-Fl. Schles. 3 (1) : 130, *non Diderma ochraceum* Hoffm. 1795.1892. *Physarum rostafinskii* Mass., Mon. 301.

Sporangia depressed, globose or irregular, sessile, more or less aggregated and often angular by mutual pressure, 0.3–0.5 mm. broad, ochraceous yellow; peridium double, the outer thick, cartilaginous, at length irregularly ruptured and reflexed, disclosing the more delicate, ashen gray inner membrane which encloses capillitium and spores; capillitium abundant, showing large, white irregular calcareous thickenings which are often consolidated and in some sporangia tend to aggregate at the center forming a pseudocolumella; spore-mass brown, spores violaceous, slightly roughened, 8–10  $\mu$ .

This beautiful species shows a peridium as distinctly double as in any diderma. The outer peridium is reflexed exactly as in some species of that genus; is yellow without, white within and withal long-persistent. The capillitium of course distinguishes the species instantly as a physarum. It is distinguished from *P. contextum* by the size of the spores. This being a decisive specific character the synonymy prior to Rostafinski is uncertain. The specific name adopted by the Polish author is therefore approved, although perhaps not the earliest.

Rare in North America, but widely distributed there and in Europe; India.

23. *PHYSARUM CONTEXTUM* Pers.

Syn. Meth. Fung. 168. 1801.

Pl. VI, Figs. 101, 102.

1796. *Diderma contextum* Pers., Obs. Myc. 1 : 89.1818. *Didymium contextum* Fr., Symb. Gast. 20.1849. *Leocarpus contextus* Fr., Summ. Veg. Scand. 450.1873. *Diderma ochroleucum* Berk. & Curt., Grev. 2 : 52.1876. *Diderma flavidum* Pk., Rept. N. Y. State Mus. 28 : 54.1892. *Physarum conglomeratum* Mass., Mon. 304, *non* Rost.

Sporangia distinct or subplasmodiocarpous, sessile, densely crowded, oval, reniform or elongated, 0.3–0.6 mm. wide; peridium double, the outer rather thick, calcareous, yellow or yellowish white, rarely pinkish buff, the inner thin, yellowish or pallid; capillitium white, containing numerous large, irregular calcareous granules; columella none; spores deep violet, distinctly and irregularly spinulose, 11–13  $\mu$ .

This singular species occurs not rarely upon the bark of fallen twigs, upon bits of straw or grass stems lying undisturbed upon the ground.

In such a position the slime mold covers, as with a sheath, the entire substratum. The outer peridium, especially its upper part, is entirely evanescent. Not rare in summer and autumn.

New England to Washington and Nicaragua, also West Indies; Europe, India.

24. *PHYSARUM MORTONI* *Macbr.*

N. A. Slime-Moulds ed. 2. 58. 1922.

Pl. V, Figs. 72, 73.

1925. *Physarum contextum* Pers. var. *mortoni* G. List., Mycetozoa ed. 3. 60.

Sporangia gregarious, clustered but distinct, sessile or with short stipe, 0.7–0.8 mm. in diameter, bright ochraceous yellow to pallid; peridium double, the outer layer rough, breaking up into rather few large deciduous scales, the inner whitish, ochraceous or olivaceous, nodular-calcareous, both persisting below to form a distinct cup; capillitium lax, the nodes white, large, angular; columella none; hyphothallus scanty, colorless; spores dark purplish brown, rather coarsely warted, 11–13  $\mu$ .

A very distinct species, related, no doubt, to *P. contextum*, but different in habit, character of peridium and with darker, more coarsely warted spores. It is never crowded, is only rarely plasmodiocarpous and the outer peridium is generally deciduous except at the base and flaps in flakes.

Colorado, Oregon, Washington.

25. *PHYSARUM BRUNNEOLUM* (*Phill.*) *Mass.*

Mon. 280. 1892.

1877. *Diderma brunneolum* Phillips, Grev. 5 : 114.

Sporangia scattered or gregarious, but not crowded, globose, turbinate or subdepressed, rarely plasmodiocarpous, 0.6–1.7 mm. in diameter, sessile or with a short stipe; peridium double, thick, smooth or polished, yellow-brown without, stellately dehiscent, the segments reflexed, white within; stipe, when present, short, stout, rugose, limeless, red-brown; columella none, but pseudocolumella sometimes present; capillitium dense, the nodes numerous, large, irregular, white, the internodes thin, short, colorless; spores globose, lilac, clearly echinulate, 8–10  $\mu$  (Lister), 6–7  $\mu$  (Masse).

What seems to be an otherwise typical specimen has spores averaging 12.5  $\mu$ .

This form was first described by Phillips as a diderma. Later students of the specimens preserved by Phillips agree that it is not a

diderma, but a craterium (Lister) or physarum (Masse). There seems no reason why we should not respect the decision of Masse, whose description is here quoted in somewhat abridged form. The peridium is about as double as in many physarums, not more so; the inner membrane so delicate as only occasionally to be revealed except to searching scrutiny. But the appearance as a whole is as of some brown diderma; only the calcareous capillitium abides to prevent mistaken reference.

When opened by irregular dehiscence from above, the persisting cup-like base of the sporangium recalls *Leocarpus fragilis*; but then again the capillitium is different.

Rare but widely distributed. Colorado, Montana, California, Chile; Europe, Australia.

## 26. PHYSARUM ÆNEUM (*List.*) *R. E. Fries*

Arkiv Bot. 1 : 62. 1903.

Sporangia sessile, subglobose or forming simple plasmodiocarps 0.3–0.4 mm. in diameter, pinkish brown or bronze, glossy; peridium double, the outer somewhat cartilaginous, brittle, falling back from the shining, membranous inner wall; capillitium dense, the nodules not large, brown, sometimes aggregated to form a pseudocolumella; spores pale brownish violet, nearly smooth, 6–8  $\mu$ .

Reported from West Indies, Bolivia; India.

## 27. PHYSARUM BOGORIENSE *Racib.*

Hedwigia 37 : 52. 1898.

1873. *Diderma pallidum* Berk. & Curt., Grev. 2 : 52, without description.

1898. *Physarum pallidum* (B. & C.) Lister, Jour. Bot. 36 : 117.

Sporangia sessile, subglobose, oval or forming elongate but not reticulate plasmodiocarps, semicircular in transverse section; peridium double, the outer thick, smooth, yellow or brown on the outside, white inside, dehiscing in stellate fashion into persistent, more or less triangular, reflexed lobes, remote from the thin, colorless or somewhat iridescent inner wall; capillitium consisting of numerous large white smooth-walled rounded and branching lime-knots connected by slender hyaline threads; spores bright violet, "nearly smooth" or covered with rather coarse warts, 7.5–8.5  $\mu$ , sometimes up to 10  $\mu$ .

A distinct species, marked by its diderma-like, brown, distant outer coat, with lobed or stellate dehiscence, and semicircular or somewhat

depressed cross section. Perfectly normal spores in some sporangia range from 8.5–10  $\mu$ .

Brandza (1929) reports this species as occurring under two aspects in Moldavia, one form with simple, pallid sporangia, strongly compressed laterally, the other plasmodiocarpous and chamois colored. The former suggests certain aspects of *P. bivalve*.

Widely distributed in tropical and warm temperate climates in both hemispheres. Less common in cooler regions but reported from New York, California, Colorado and Pennsylvania.

## 28. PHYSARUM PENETRALE *Rex*

Proc. Ac. Nat. Sc. Phila. 1891 : 389.

Pl. IV, Figs. 65, 66, 67.

1896. *Cytidium penetrale* (Rex) Morgan, Jour. Cin. Soc. Nat. Hist. 19 : 11.

Sporangia scattered, stipitate, erect or nodding, ellipsoidal or pyriform, 0.4–0.6  $\times$  0.3–0.4 mm., rarely globose; peridium greenish gray or yellowish green, studded sparsely with rounded, pale yellow or yellow-gray lime granules, rupturing to the base into two or four segments; stipe variable, slender, subulate, rugulose, flattened laterally toward the base, translucent, dull red or golden red in color; columella four-fifths the height of the sporangium, concolorous with the stipe, acuminate; capillitium dense, persistent, the nodes frequently calcareous, rounded, yellow; spore-mass brown, spores nearly smooth, brownish, 6–7  $\mu$ .

Readily recognizable by the elongate sporangia and the lengthened columella. The capillitial nodes are at first pale yellow, but tend to whiten on exposure. The spores when highly magnified show delicate spinulose.

Cosmopolitan. Not common in North America. A specimen in the Ellis collection, New York, from Dr. Rex, is labelled *P. columelliferum* but this name seems not to have been published.

## 29. PHYSARUM PUNICEUM *Emoto*

Bot. Mag. Tokyo 45 : 229. 1931.

Sporangia clustered, cylindrical, stalked, bright pink, 0.5–1 mm. tall, 0.4–0.5 mm. broad; stalk up to 0.15 mm. tall and 0.05 mm. thick, sometimes almost lacking, bright purple-red, longitudinally striate; peridium thin, membranous, bright rose, encrusted with small round crystals 1  $\mu$  in diameter; hypothallus round, concolorous with the stalk; columella always present, conspicuous, bright pink, stout, cy-



lindrical, 0.1 mm. thick, almost reaching the top of the sporangium and remaining after the breaking away of the sporangium wall; capillitium delicate, the threads almost colorless, with enlarged ends, the nodes white, few, of various forms and sizes, filled with small round crystals  $1\ \mu$  in diameter; spores spherical, violet-brown, thickly covered with flat warts, 6–8  $\mu$ .

Distinguished by the color, the stalk, the columella, the delicate capillitium and the size of the spores.

Known only from southern Manchuria, on living leaves.

### 30. *PHYSARUM CRATERIFORME* Petch

Ann. R. Gard. Perad. 4 : 304. 1909.

Sporangia gregarious or solitary, grayish white or pale brown, globose, clavate or crateriform, 0.4–0.6 mm. in diameter, stipitate or sometimes sessile, 1–2 mm. in total height; stalk when present opaque, conical, black, or black below and white above; columella cylindrical, often reaching the apex of the sporangium, or shorter, then clavate or conical, concolorous with the stipe or paler, occasionally lacking; capillitium various, strongly calcareous, the nodules either massed about the columella, or, in the globose sporangia, rod-like and ascending; spores closely spinulose, 10–13  $\mu$ .

Iowa, Antigua; western Europe, West Africa, Ceylon, Japan.

### 31. *PHYSARUM LISTERI* Macbr. *nom. nov.*

Pl. V, Figs. 74, 75.

1904. *Physarum luteo-album* List., Jour. Bot. 42 : 130, *non* Schum.

Sporangia gregarious, subglobose, large, about 1 mm. in diameter, yellow, shading into white, orange or olivaceous, smooth or rugulose, stipitate; stipe stout, smooth, 0.5–1 mm. high, yellow or orange above, white below, cylindric, lime-stuffed; columella large, subglobose or clavate, yellow; capillitium either of very slender pale yellow threads, branching at acute angles and anastomosing, or of broad, yellow, simple or forked strands, persistent after spore dispersal; nodules few, small, linear or fusiform; spores purple-brown, coarsely and somewhat irregularly spinulose, 10–13  $\mu$ . Plasmodium orange.

The general plan of structure corresponds very well with Fries' idea of his genus *Tilmadoche*, although the present species would seem, by very grossness, strangely out of place with the *tilmadoches*. But the singular didermoid, evenly branching threads of the capillitium bearing their slender spindle-shaped burdens of lime are very



suggestive; it is a diderma gone wandering into the camp of the physarums if one may judge from Miss Lister's graphic plate.

The name given to this species by Mr. Lister is antedated by over a century. Schumacher (Enum. Pl. Sæll. 2 : 199. 1803) gave the name to what Fries thought was a perichæna; at any rate not a physarum. Fries makes Schumacher's combination a synonym for *Perichæna quercina* Fr., which Rostafinski in turn makes synonymous with *Perichæna corticalis* (Batsch) Rost. According to the International Rules as revised at Cambridge, the name *Physarum luteo-album* cannot be revived even though the earlier name is universally regarded as non-valid. A new name must, therefore, be applied, and we suggest *listeri*, as suggested in N. A. Slime-Moulds, 2nd ed., p. 71.

Var. *aureum* Rönn, as distributed by Jaap, No. 84, does not seem to differ from the typical form sufficiently to justify its recognition.

Colorado; Europe, India.

### 32. PHYSARUM PERFECTUM *M. E. Peck*

Am. Jour. Bot. 19 : 134. 1932.

Sporangia loosely gregarious, grayish white, globose, stipitate, 0.6–0.8 mm. in diameter; hypothallus very thin, colorless, wide spreading; stipe yellowish white, stout, calcareous, nearly smooth, slightly narrowed upward, equalling or a little surpassing the diameter of the sporangium; columella well developed, white, conical, nearly one-third the height of the sporangium; peridium a thin membrane, evenly granular with included lime and thickly sprinkled with round, mainly superficial, white scales of lime; capillitium moderately dense with abundant, rounded and elongated, pale yellowish, calcareous nodes; spores minutely roughened, violaceous brown, 10–11  $\mu$ .

Seemingly a well-marked species, having a trim, finished appearance. Two or three colonies have been found in the neighborhood of Salem, Oregon. The most striking structural feature is the stipe. Other features suggest *P. melleum* (Berk. & Br.) Mass., but the color and greater size at once distinguish it.

Oregon: on decaying bark of *Populus* sp.

### 33. PHYSARUM GLOBULIFERUM (*Bull.*) *Pers.*

Syn. Meth. Fung. 175. 1801.

Pl. V, Figs. 76, 77, 78.

1791. *Sphærocarpus globulifer* Bull., Champ. 134.

1791. *Stemonitis globulifera* (Bull.) Gmel., Syst. Nat. 2 : 1469.

1805. *Trichia globulifera* (Bull.) DC., Fl. Fr. 2 : 253.

1829. *Diderma globuliferum* (Bull.) Fr., Syst. Myc. 3 : 100.  
 1876. *Physarum petersii* Berk. & Curt. var. *farlowii* Rost., Mon. App. 6.  
 1876. *Didymium subroscum* Pk., Rept. N. Y. State Mus. 28 : 54.  
 1878. *Physarum albicans* Pk., Rept. N. Y. State Mus. 30 : 50.  
 1893. *Physarum columbinum* Macbr., Bull. Lab. Nat. Hist. Iowa 2 : 384, *non* Pers.  
 1896. *Cytidium globuliferum* (Bull.) Morg., Jour. Cin. Soc. Nat. Hist. 19 : 10.  
 1896. *Physarum relatum* Morg., Jour. Cin. Soc. Nat. Hist. 19 : 26.

Sporangia gregarious, stipitate, globose or slightly depressed above, about 0.5 mm. in diameter, pale blue-gray to pure white or sometimes rosaceous; stipe calcareous, extremely brittle, at least equal to the sporangium, usually longer, slender, slightly wrinkled, white, pallid or yellow, when long tapering upward; columella white, conical, sometimes obsolete; hypothallus scanty, inconspicuous; capillitium dense, but delicate, persistent, a close network of hyaline threads, with white or yellowish nodes sparingly thickened and calcareous, many without lime; spore-mass brown; spores violet by transmitted light, minutely warted, the warts in indistinct clusters, 7.5–9  $\mu$ . Plasmodium yellow or greenish yellow according to published records. We have a collection (S. U. I. 1485), typical in every respect, which developed from a pale violet plasmodium, without a trace of yellow.

This species, very common eastward, is at once very beautiful and very variable. Its several phases have been again and again observed and described too often by distinct specific or varietal names. A form from New York, with long, white stems and almost pure white sporangia, is *P. albicans* Peck. Forms occur like *P. albicans*, but flushed with rose throughout. From New England, specimens sent Rostafinski were by him deemed a variety of *P. petersii* Berk. & Curt., and called *P. petersii* var. *farlowii* Rost. By this name the species has been generally distributed in this country. Most gatherings of this species have small, somewhat ochraceous sporangia, and pale yellow, or somewhat rusty stipes. These latter, with somewhat heavier stem, represent *Physarum simile* Rost. A form collected sparingly in Iowa has short, white stipes and blue-gray sporangia one-third larger than observed in the eastern types. This was recorded as *P. columbinum* Macbr., a name already in use. The spores in the Iowa specimens are also a little larger, 8–10  $\mu$ . Pale cyanic and roseate forms also sometimes occur in late fruitings.

In all phases the persistent tenacity of the capillitium is a striking characteristic well noticed by Fries (Syst. Myc. 3 : 101): "Peridia a gleba omnino libera, dein tota diffracta, evanescentia, . . . capillitio compacto forma servata persistente." The peridium, except a small

part below, all falls away, leaving the capillitium apparently intact, crowded with spores.

Canada south to Mexico; apparently, in one form or another, cosmopolitan.

Var. *confluens* Brandza, Bull. Soc. Myc. Fr. 44 : 255, 1929, has sessile or plasmodiocarpous, densely aggregated sporangia.

#### 34. *PHYSARUM MURINUM* List.

Mycetozoa 41. 1894.

Pl. V, Figs. 79, 80.

1891. *Physarum braunianum* Lister, Jour. Bot. 29 : 259, *non* Rost.

1896. *Cytidium ravenelii* (B. & C.) Morgan, Jour. Cin. Soc. Nat. Hist. 19 : 10.

1899. *Physarum ravenelii* (B. & C.) Massee ex Macbr., N. A. Slime-Moulds 48.

1923. *Physarum heterosporum* Widder, Verh. Zool.-Bot. Ges. Wien 73 : 159.

Sporangia scattered, globose or perfectly spherical, ashy brown, rugulose, stipitate; stipe elongate, pale brown, erect, generally tapering upward, calcareous, brittle; hypothallus none; columella short, hemispherical or bluntly conical; capillitium dense, much as in *P. globuliferum*, the calcareous nodules umber, brownish or orange-yellow, small; spore-mass brown; spores by transmitted light bright lilac, finely warted, the warts somewhat clustered, 8–11  $\mu$ .

A very distinct species, easily known by its peculiar drab colored peridium and dull brown stalks. The author of the species allows for the capillitial nodes no other tint but brown. Under direct illumination many gatherings, especially where the sporangia are well blown out, show nodules of a bright orange tint.

Morgan regarded his *Cytidium ravenelii* as the same as Berkeley and Curtis' *Didymium ravenelii*. Lister, however, finds that the type of the latter species is referable to *P. pulcherripes* Pk. Morgan's description seems to refer to the present species rather than to *pulcherripes* and his name is therefore retained in the synonymy.

Not rare in the eastern United States, to Missouri and Iowa, also Washington; western Europe.

#### 35. *PHYSARUM MELLEUM* (Berk. & Br.) Massee

Mon. 278. 1892.

Pl. IV, Figs. 68, 69, 70, 71.

1873. *Didymium melleum* Berk. & Br., Jour. Linn. Soc. 14 : 83.

1873. *Didymium chrysopeplum* Berk & Curt., Grev. 2 : 53.

1876. *Physarum schumacheri* Spreng. var. *melleum* Rost., Mon. App. 7.

1892. *Physarum kalchbrenneri* Massee, Mon. 297.

1896. *Cytidium melleum* (Berk. & Br.) Morgan, Jour. Cin. Soc. Nat. Hist. 19 : 11.

Sporangia scattered, stipitate, globose, somewhat flattened below, 0.4–0.5 mm. in diameter, wall rugose, clear yellow or honey colored;

stipe conical, short, about equal to the sporangium, somewhat wrinkled, white or yellow; sometimes tawny; columella small but distinct, concolorous with the stipe; hypothallus white, scanty, often lacking; capillitium abundant, snow-white, with rather large angularly stellate nodes; spores pale violet by transmitted light, almost smooth, 7.5–10  $\mu$ . Plasmodium yellow.

Easily distinguished by its pale stipe and columella and white capillitium in contrast with the yellow peridial walls. N. A. F. 1395 is this species. Massee refers it erroneously to *P. schumacheri* Spreng. The description and specimen do not correspond. By that name the species has, however, been hitherto known in the United States. In culture brilliant orange sclerotia are formed on a white, strand-like hypothallus.

Common in the eastern United States, rare west of the Mississippi, Puerto Rico, Brazil, Bolivia; world-wide.

### 36. *PHYSARUM CITRINUM* Schum.

Enum. Pl. Sæll. 2 : 201. 1803.

1818. *Physarum compactum* Ehr., Sylv. Myc. Berol. 26.

1827. *Physarum schumacheri* Spreng., Syst. Veg. 4 : 528.

1829. *Diderma citrinum* (Schum.) Fr., Syst. Myc. 3 : 100.

1846. *Physarum aureum* var. *chrysopus* Lev., Ann. Sc. Nat. Bot. 3 ser. 15 : 166.

1876. *Physarum leveillei* Rost., Mon. App. 7, in part.

1896. *Cytidium citrinum* (Schum.) Morg., Jour. Cin. Soc. Nat. Hist. 19 : 9.

Sporangia gregarious, scattered, globose, 0.4–0.7 mm. in diameter, somewhat flattened below, pale yellow, citrine, stipitate or nearly sessile; peridium thin, covered almost completely with small calcareous scales; stipe stout, erect, fragile, tapering upwards, furrowed, yellow, opaque, arising from a small hypothallus which is sometimes continuous from one sporangium to the next; columella small, conical, yellow; capillitium a rather dense, delicate network, the calcareous nodules yellow, numerous, roundish, and generally small; spore-mass black; spores under the lens violaceous, almost smooth, about 8–10  $\mu$ .

This species seems to be rare in the United States. It somewhat resembles *P. melleum*, from which it is distinguished by its brighter color and yellow nodes, and its denser capillitium. *P. galbeum* is a smaller form, and lacks the columella. Rostafinski strangely confused the synonymy.

Var. *sessile* Meylan is reported from Switzerland and Rumania. In our material it seems to merge into the typical form.

New England, Ohio, Colorado, Washington, South America; Europe, South Africa, Australia.



37. *PHYSARUM PULCHERRIPES* Peck

Bull. Buff. Soc. Nat. Hist. 1 : 64. 1873.  
Pl. V, Figs. 81, 82.

1873. *Didymium erythrinum* Berk., Grev. 2 : 52.  
1873. *Didymium ravenelii* Berk. & Curt., Grev. 2 : 53.  
1873. *Physarum petersii* Berk. & Curt., Grev. 2 : 66.  
1875. *Physarum schumacheri* Spr. var. *rufipes* A. & S. ex Rost., Mon. 99.  
1876. *Physarum psittacinum* Ditm. var. *ravenelii* Rost., Mon. App. 8.  
1888. *Physarum pulchripes* Berl., Sacc. Syll. Fung. 7 : 349.  
1896. *Cytidium rufipes* (A. & S.) Morg., Jour. Cin. Soc. Nat. Hist. 19 : 9.  
1899. *Physarum rufipes* (A. & S.) Macbr., N. A. Slime-Moulds 50.

Sporangia globose, 0.5–0.7 mm. in diameter, yellow-orange to tawny brown with lime deposits, dark iridescent beneath, the walls thin, deciduous; stipitate, the stipe slender, erect, deep red, sometimes black below, pale or orange above, and supported on a well-developed hypothallus; columella small, conical or subglobose; capillitium dense, the meshes and nodes unusually small and delicate, the latter reddish or yellow; spore-mass dark violaceous gray; spores by transmitted light pallid, faintly warted with clusters of darker warts, violet, 8–10  $\mu$ . Plasmodium probably yellow.

The striking contrast of color between sporangia and stipes renders this species at sight quite distinct from any related form. The peridia in the specimens before us are black or iridescent sprinkled more or less profusely with orange lime granules which sometimes cover all but the base. The stipe, springing from a small hypothallus, is dark red below for about one-fourth its height, then vermilion, above expanding slightly beneath the peridium. The capillitium is a delicate net, with numerous small, uniformly regular, orange, calcareous nodes.

This species is no doubt related to *P. psittacinum*. It is, however, much smaller, has a calcareous stipe, and a much less variegated peridium, and generally a small columella. It is also akin to *P. globuliferum* and to *P. murinum*.

Eastern United States, Washington; not common. Reported from Ireland.

38. *PHYSARUM PULCHERRIMUM* Berk. & Rav.

Grev. 2 : 65. 1873.  
Pl. V, Figs. 83, 84.

1873. *Stemonitis porphyra* Berk. & Curt., Grev. 2 : 69.  
1879. *Physarum atrorubrum* Pk., Rept. N. Y. State Mus. 31 : 40.  
1896. *Cytidium pulcherrimum* (B. & R.) Morgan, Jour. Cin. Soc. Nat. Hist. 19 : 8.



Sporangia scattered or gregarious, globose, even, or somewhat wrinkled, dark red, reddish violet or purple, stipitate; stipe cylindric, even, subconcolorous or blackish; columella small or none; capillitium free from spores, whitish, with a slight pinkish tinge; spores dark brown in mass, dark red when separated, globose, smooth, 7.5–8.5  $\mu$ . Plasmodium dark red.

The capillitium is very delicate, and when cleared of spores the knot-like thickenings are seen to be very small and of a dark red color, to which is probably due the pinkish tinge which marks the whole. A part only of the thickenings are filled with lime granules. The dark red granules of the sporangium walls are abundant and appear to form a continuous crust.

This is *P. atrorubrum* Peck, and his description has been closely followed. The very brief description in Grevillea, however, antedates the New York publication and, all inadequate as it is, no doubt applies to the same thing.

Not rare. Eastern and central United States and Canada, Washington; Rumania, Ceylon, Malay Peninsula.

#### 39. PHYSARUM LILACINUM *Sturgis & Bilgram, non Fr.* 1829

Mycologia 9 : 324. 1917.

Sporangia gregarious, stalked, globose, erect, pale lilac to pale Indian-red in color, 0.5 mm. in diameter; sporangium wall membranous, beset with rounded masses of lilac or reddish lime; stipe erect, broad-based, tapering upwards, calcareous, furrowed, paler than the sporangium or concolorous, 0.7–0.9 mm. long, about 0.1 mm. thick; columella conical or columnar; capillitium delicate, rigid, persistent; lime-knots small, rounded, composed of large, pale lilac or reddish, spherical granules. Spores pale brown, almost smooth, 7–8  $\mu$ .

Miss Lister records as var. *cæruleum* (Mycetozoa, 3rd ed., 30) a form with pale blue sporangium, lime-knots and stalk, collected with the typical form.

Reported thus far only from Philadelphia.

#### 40. PHYSARUM NUCLEATUM *Rex*

Proc. Ac. Nat. Sc. Phila. 1891: 389.

Pl. V, Figs. 85, 86, 87.

Sporangia gregarious, spherical, 0.5 mm. in diameter, white, stipitate; peridial wall membranaceous, rupturing irregularly, thickly studded with rounded white lime granules; stipe about 1 mm., subulate, yellowish white, rugose; columella none; capillitium dense, snow-

white, with minute, white, round or rounded nodes, in the center a conspicuous mass of lime forming a shining ball, not part of the stipe although sometimes produced toward it; spore-mass black; spores brown-violet, delicately spinulose, 6–7  $\mu$ .

This species most nearly resembles in appearance and habit of growth *P. globuliferum* Pers., but may be distinguished from it by the absence of a columella, by the central ball of lime, and the very small rounded lime granules in the meshes of the capillitium. Exceptionally the lime granules of the sporangium wall are sparse or absent entirely, in which case the wall has a silvery or coppery metallic luster.

Var. *robustum* G. Lister (Jour. Bot. 64 : 226, 1926) is larger, with a very short stipe and a blue or coppery, iridescent peridium.

New York, Pennsylvania, Maryland, Wisconsin, Iowa, Nicaragua; Europe, South Africa, Japan; the tropics generally.

#### 41. PHYSARUM WINGATENSE *Macbr.*

N. A. Slime-Moulds ed. 2. 72. 1922.

Pl. V, Figs. 91, 92.

1876. *Tilmadoche columbina* Rost., Mon. App. 13.

1889. *Tilmadoche compacta* Wing., Proc. Acad. Nat. Sc. Phila. 48.

1892. *Didymium barteri* Massee, Mon. 231.

1892. *Lepidoderma stellatum* Massee, Mon. 252.

1894. *Physarum compactum* (Wing.) List., Mycetozoa 44.

1916. *Physarum columbinum* (Rost.) Sturgis, Mycologia 8 : 200.

Sporangia gregarious or somewhat crowded, stipitate, erect or cernuous, gray, brownish gray or bronze, globose; peridium thin, metallic brown or bronze in color, splitting at maturity in floriform manner into six to twelve segments; stipe limy, white or yellowish, often shading to black or fuscous below, rather long, tapering upward; hypothallus none; columella none; capillitium extremely delicate, white or colorless, usually radiating from a central lime-mass or nucleus, and with ordinary nodules small and few, fusiform; spore-mass brown; spores by transmitted light violet-brown, delicately warted, 7–9  $\mu$ . Plasmodium light gray.

This species is well marked by several characteristics; the brilliant wall of the peridium, white-flecked and lacinate, the delicate didymium-like capillitium running from center to peridium, and especially the peculiar aggregation of lime at the center of the sporangium, like nothing else except a similar structure found in *Physarum nucleatum* Rex. The variations affect the stipe and the distribution of the capillitium lime. Some eastern specimens show stipes black below; specimens from Ohio and Nicaragua show stipes milk-white throughout. As to

the capillitium, in some of the Nicaragua collections the lime is more uniformly distributed through the capillitium, and accordingly the nucleus is not conspicuous, its place being taken by two or three nodes plainly larger than the others. The peculiar brown metallic luster of the peridial wall and the strongly developed calcareous patches with which the peridium is covered are fairly constant features. Rostafinski called it a *tilmadoche*, with which group it might easily be placed. The capillitium is, however, distinctly netted.

The name *Didymium columbinum* Berk. & Curt. was never published, although fragmentary remains under this name exist in both the Berkeley and the Curtis herbaria. Rostafinski based his *Tilmadoche* on Berkeley's specimen, and Miss Lister, who has examined it, believes it is the same as *Tilmadoche compacta* Wingate. This is confirmed by Sturgis, after an examination of the material in the Curtis herbarium. *Physarum columbinum* Pers. is universally recognized as having been applied to *Lamproderma columbinum*; *Physarum columbinum* Somm. may have been the same thing although Fries regards it as distinct from the form he cites as *columbinum*. His description, however, strongly suggests a lamproderma. But whatever they may be, the name cannot again be used. Masee's names are cited on the authority of Lister. One or the other may eventually have to be adopted. For the present, *wingatense* will serve to designate the species as it occurs in North America.

North and South America and West Indies; Africa, southern Asia, Malay Peninsula, Japan.

#### 42. *PHYSARUM DIDERMOIDES* (Ach.) Rost.

Mon. 97. 1875.

Pl. V, Figs. 88, 89, 90.

- 1801. *Spumaria* ? *didermoides* Acharius, in Pers. Syn. Fung. Add. xxix.
- 1803. *Diderma oblongum* Schum., Enum. Pl. Sæll. 2 : 197.
- 1832. *Physarum atrum* Schw., Trans. Am. Phil. Soc., II. 4 : 257.
- 1832. *Spumaria licheniformis* Schw., Trans. Am. Phil. Soc. II. 4 : 261.
- 1849. *Claustria didermoides* (Ach.) Fr., Summ. Veg. Scand. 2 : 451.
- 1850. *Didymium congestum* Berk. & Br., Ann. Mag. Nat. Hist. 2 ser. 5 : 365.
- 1875. *Physarum lividum* Rost., Mon. 95.
- 1875. *Physarum lividum* Rost., var. *licheniforme* Rost., Mon. 96.
- 1882. *Physarum cinereum* (Batsch) Pers. var. *ovoideum* Sacc., Michelia 2 : 334.

Sporangia crowded, ovoid or cylindric, 0.4–0.6 mm. broad, stipitate or sessile, blue-gray, often capped with white; stipe variable in length and structure, where well developed pure white, often flattened, expanded and diaphanous, connate with others through the irregular, reticulate or sheet-like hypothallus; columella none; capillitium ample,

the lime-knots angular or rounded, white, connected by hyaline threads; spores in mass black, by transmitted light dark violet, densely spinulose, 12–15  $\mu$ . Plasmodium watery white or gray.

A very variable species in many particulars. The sporangia in the same cluster are stipitate and sessile, ovoid and spherical. Our description does not quite agree with that of Rostafinski; it is the outer peridium that is with us white, burdened with lime; the inner is simpler and comparatively thin. The whiteness of the outer peridium is, however, easily displaced. The colony may not show it at all, in which case the peridia remaining give to the entire fructification a pale lead color, very characteristic. The disposition of the lime in the capillitium is also notably variable. Specimens occur which suggest Rostafinski's *Crateriachea*; that is, the lime is massed as a snow-white pseudocolumella in the center of each sporangium. In such cases the lime of the outer peridium may be scanty or limited in amount, not forming a calcareous cap. The size of the spores is also variable. Rostafinski gives 12.5–14.2  $\mu$ ; not infrequently a single spore reaches 16  $\mu$ , a very unusual range of variation.

The species is fairly common in the upper Mississippi valley, and can be obtained in quantity where once it appears, as the plasmodia are profuse.

*Physarum lividum* Rost. (Mon. 95) is but a less calcareous form of this, as is evident even by the author's description. Professor Morgan thought *P. lividum* a phase of *P. griseum* Lk. Link, however, reckons *P. griseum* the same as *P. cinereum*.

Forms without a stipe, with thinner sporangium wall and with spores paler and smoother on one side are segregated as the var. *lividum* Lister in the English monograph.

Eastern North America to Kansas, Washington, Nicaragua. Especially to be looked for on the bark of fallen stems of *Populus* and *Negundo*. Also South America; Europe, Asia, Africa.

#### 43. *PHYSARUM MUTABILE* (Rost.) Lister

Mycetozoa ed. 2. 53. 1911.

1875. *Crateriachea mutabilis* Rost., Mon. 126.

1894. *Physarum cinereum* (Batsch) Pers. ex List., Mycetozoa 55, in part.

1895. *Physarum crateriachea* List., Jour. Bot. 33 : 324.

Sporangia ovoid, cylindrical or subglobose, 0.4–0.6 mm. in diameter, stalked or sessile, sometimes plasmodiocarpous, white, becoming yellowish gray with the disappearance of the peridium, sessile or stipitate, stipes when present yellow, with or without lime, often con-



nected by a hypothallus; peridium thin, squamulose; capillitium persistent, intricate, the nodules white, more or less confluent at the center to form a real or a pseudocolumella; spores brownish purple, spinulose, 7-10  $\mu$ . Plasmodium grayish, translucent.

The lime-knots may often form a pseudocolumella reaching nearly to the top of the sporangium. Brandza reports plasmodiocarpous forms from Rumania, developed as a result of unfavorable weather conditions.

Forms with a capillitium nearly free from lime, the calcareous material aggregated in the center to form a robust cylindrical columella, such as distributed by Professor Brandza (No. 15), seem very close to *Diachea*.

Reported from Europe, Africa, Ceylon, Japan.

#### 44. *PHYSARUM NICARAGUENSE Macbr.*

Bull. Nat. Hist. S. U. Iowa 2 : 382. 1893.

1894. *Physarum compressum* Alb. & Schw. ex Lister, Mycetoza 53, in part.

1911. *Physarum reniforme* Lister, Mycetoza ed. 2. 72, in part.

Sporangia multilobate or compound-contorted, below obconic, gray, ribbed with calcareous thickenings; stem short, fuscous, longitudinally wrinkled; hypothallus distinct, black; columella none, although the lime massed at the center of each sporangium simulates one; capillitium white, densely calcareous, with heavy angular nodules connected with comparatively short threads; spores violet, globose, spinulose, about 12  $\mu$  in diameter.

This species somewhat resembles *Physarum notabile*, especially in the amount of lime present in both capillitium and peridium, in the fluted, sooty stipe, and the rough spores. Mr. Lister once regarded it as the same. Nevertheless, it differs from that species in many definite particulars. In the first place, the sporangia are persistently different in form and habit. They are obconic, nearly always compound, convolute, or botryoid, in this respect somewhat resembling *P. polycephalum*. Besides, the sporangia are uniformly much smaller, and show constantly the strongly calcified center, much transcending anything seen in *P. notabile*. The stipe also is peculiar, quite short, an upward extension or sweep of the common hypothallus which is usually very distinct or prominent; and, while the stipe is longitudinally wrinkled, it is much less so than in the related species, and in a different way. The spores are about the same in size, but differ in color, in this respect agreeing rather with *P. leucophæum*.

In the Mycetoza, 2nd edition, the present species is entered as a synonym of two described by Masee: *Tilmadoche reniformis* Mass.,



Mon. 336, and *Didymium echinosporum* Mass., Mon. 239. But Massee's description of his *Tilmadoche* is, naturally enough, at variance in every important point with the facts in the species before us. Massee describes the sporangia as deeply umbilicate below, sausage-shaped and curved; the stem elongated, slender, erect, pale brown; capillitial nodes scattered, fusiform, colorless or yellow; spores 16–17  $\mu$ . It is evident that whatever Massee may have had in hand as he wrote, it was not *P. nicaraguense*, which has spores 10–12  $\mu$  and reverses the remaining description.

But *Didymium echinosporum* also defines *T. reniformis*, since Lister says they are based on two gatherings of one species. Of *echinosporum* Massee says: "Bearing a superficial resemblance to *Tilmadoche nutans*, but distinct in the capillitium, which contains no trace of lime, and in the spores," the dimensions of the latter being given as 12–14  $\mu$ . Again it is evident that whatever Massee had in hand when he wrote, it was not *P. nicaraguense* in which the capillitium is almost *Badhamia*-like, i. e., burdened with lime!

Worse than all, Mr. Massee's alleged types are in evidence; one labelled *P. reniforme* includes forms of *P. didermoides* and of *P. nicaraguense*; the other, labelled by Berkeley *P. nutans*, is *P. nicaraguense* according to Petch, Mycet. Ceyl., who enters our species as from Ceylon, and the names cited from Berkeley, Massee and others, as synonyms. He remarks: "Probably Thwaites' 135 and 55 were mixed during examination"! Doubtless! and some other things too! What Massee did have beneath his lens, no one now may say but apparently not in either case cited the physarum of Central America.

Nicaragua; Ceylon, perhaps throughout the tropics.

#### 45. PHYSARUM DISCOIDALE *Macbr.*

N. A. Slime-Moulds ed. 2. 74. 1922.

Sporangia gregarious, scattered, discoidal, depressed or umbilicate above, sometimes almost annulate, snow-white, small, 0.5–0.7 mm. in diameter, stipitate; stipe about twice the sporangium, pale yellow, strand-like, but erect, even; hypothallus none; columella none; capillitium strongly calcareous, almost as in *Badhamia*, aggregate at the center, forming a pseudocolumella at the base of the peridium; peridial wall firm, covered with innate patches of lime, somewhat yellow at the base; spores minutely spinulose, violaceous, 9–11  $\mu$ .

Miss Lister considers this a synonym of *P. javanicum* Racib. But Raciborski's description is of a larger species with thinner stalk and saucer-like sporangium, externally roughly resembling *Trichamphora*

*pezizoidea* Jungh. This description does not apply to the present species. It appears in late winter in undisturbed grass tufts and the sporangia are scattered over the lower leaves. It displays a remarkable amount of lime. The nodules, however, are not large; they are rounded and connected here and there by the ordinary tubules characteristic of a physarum.

California.

46. *PHYSARUM JAVANICUM* *Racib.*

Hedwigia 37 : 53. 1898.

1909. *Physarella javanica* (Racib.) Torr., Fl. Myx. 174.

Sporangia clustered, stalked, discoidal, somewhat convex below, deep, saucer-shaped above, erect or somewhat nodding, 1 mm. broad, 0.25 mm. deep, the wall thin, white, the surface thickly covered with small irregular lime granules, the upper part disappearing after maturity, leaving the plate-like lower portion attached to the stalk; stalk slender, grayish white, attenuate above, irregularly furrowed, arising from a small hypothallus; capillitium dense, rigid, composed of colorless, thin, often spindle-shaped tubes, connecting the numerous elongated or triangular white lime nodules; spores violet, globose, nearly smooth, 10–12  $\mu$ .

Externally resembling *Trichamphora pezizoidea* but differing in the method of dehiscence, the structure of the capillitium and the color of the stipe. Originally referred to the section Tilmadoche, but neither the description nor Miss Lister's illustration suggest this. The spore size is given as 9–10  $\mu$  in the Lister monograph. For the present we are disposed to consider *P. discoidale* distinct, as noted under that species. Höhnelt (1909) thought *P. javanicum* much nearer to *Trichamphora* than to any physarum.

Florida, Colombia; Java, South and East Africa.

47. *PHYSARUM COMPRESSUM* *Alb. & Schw.*

Consp. Fung. 97. 1805.

Pl. V, Figs. 93, 94, 95.

1875. *Physarum nephroideum* Rost., Mon. 93, in part.

1875. *Physarum lividum* Rost., var. *conglobatum* Rost., Mon. 96, in part.

1875. *Physarum candidum* Rost., Mon. 96.

1876. *Physarum affine* Rost., Mon. App. 5.

1877. *Didymium glaucum* Phill., Grev. 5 : 114.

1882. *Physarum phillipsii* Balf. fil., Grev. 10 : 116.

1892. *Physarum glaucum* (Phill.) Massee, Mon. 284.

Sporangia more or less scattered, compressed-globose, or compressed-reniform, often umbilicate, stipitate, sessile, or elongate and plasmodi-

ocarpous, calcareous, white or ashen; peridium thin, covered with squamules, opening irregularly, usually by apical cleft; stipe, when present, short, stout, more or less sulcate, dark brown or ashen; capillitium a rather loose net, the nodules white, variable in size and shape; spores purplish brown, warted, the warts sometimes irregularly grouped, about 10–12.5  $\mu$ . Plasmodium grayish white.

Rather rare in North America. Known from Pennsylvania, Iowa, Colorado, California, Oregon, Washington, also Puerto Rico, Bolivia, Argentina. Cosmopolitan.

#### 48. PHYSARUM STRAMINIPES *List.*

Jour. Bot. 36 : 163. 1898.

Sporangia grayish white, obovoid or wedge-shaped, 0.7 mm. in diameter, clustered or scattered, stipitate or sessile, when stipitate stalks long, weak; peridium membranous, pale purple; capillitium a persistent rigid net, the nodules white, rounded, sometimes aggregate as a pseudocolumella; spores purple-brown, 10–11  $\mu$ , warted, the papillæ in definite patches. Plasmodium white.

Related to *P. compressum*.

Oregon, Chile; Europe, New Zealand.

#### 49. PHYSARUM NEWTONI *Macbr.*

Bull Nat. Hist. S. U. Iowa 2 : 390. 1893.

Sporangia simple, gregarious, short-stipitate or sessile, globose or flattened, and then depressed and deeply umbilicate above, purple, smooth, thin-walled; stipe when present very short and concolorous; columella none; hypothallus none; capillitium abundant, delicate, with more or less well developed nodules, which are also concolorous; spores by transmitted light dark brown, thick-walled, rough, nucleated, about 10  $\mu$ . Plasmodium dark violet.

A very handsome little species collected by Professor G. W. Newton in Colorado, at an altitude of several thousand feet. Easily recognized by its almost sessile, rose-purple, generally umbilicate sporangia.

Colorado; Japan.

#### 50. PHYSARUM ROSEUM *Berk. & Br.*

Jour. Linn. Soc. 14 : 84. 1873.

Sporangia gregarious, globose, 0.4 mm. in diameter, rose-red, stipitate; sporangium wall membranous with innate clusters of purple-red lime granules; stalk erect, slender, brown, rugulose, translucent;

columella none; capillitium lax, delicate, lilac, the nodules few, large, purple-red, branching; spores reddish lilac or brown, minutely spinulose, 7–10  $\mu$ . Plasmodium rose-red.

Reported from Africa, Ceylon, Java, Borneo, Japan.

#### 51. *PHYSARUM PSITTACINUM* *Ditm.*

in Sturm, Deutsch. Fl. Pilze 3 : 125. 1817.

Pl. V, Figs. 96, 97.

1889. *Physarum carlylei* Massee, Grev. 17 : 56.

Sporangia scattered or gregarious, globose, depressed-globose, or reniform; iridescent-blue or bronze, mottled with various tints, red, orange, yellow, white; stipitate, stipe equal, or tapering slightly upward, rugose, orange or orange-red, without lime, rising from a small concolorous hypothallus; columella none; capillitium dense, crowded with calcareous, brilliant orange nodules which are angular in outline and tend to aggregate at the center of the sporangium; spore-mass brown; spores by transmitted light pale brown, slightly but plainly warted, 8–10  $\mu$ . Plasmodium orange-red.

Differs from *P. pulcherripes* Pk. in external coloration, the peridium being blue or bronze, mottled, but not with lime; in the capillitium, dense, calcareous, with large angular or branching nodes; in the stipe, without lime; in the spores, a little larger than in *P. pulcherripes*, and by transmitted light much more distinctly brown in color. The sporangia are also broader in the present species, reaching 1 mm.

The variety *fulvum* Lister, reported from Iowa, Ceylon, Malay Peninsula and Japan, has the lower part of the sporangium and the stipe fulvous yellow instead of red or orange.

Rare. Maine, New Hampshire, New York, Massachusetts, Pennsylvania, West Virginia. Reported common in Europe, Japan.

#### 52. *PHYSARUM LEUCOPUS* *Link*

Mag. Ges. Nat. Fr. Berl. 3 : 27. 1809.

Pl. V, Fig. 100.

1809. *Physarum bullatum* Lk., Mag. Ges. Nat. Fr. Berl. 3 : 27. 1809.

1829. *Didymium leucopus* (Lk.) Fr., Syst. Myc. 3 : 121.

Sporangia gregarious, stipitate, globose, 0.5 mm. in diameter, snow-white, with a didymium-like covering of calcareous particles; stipe white, not long, conical or tapering rapidly upward, slightly sulcate, brittle, from an evanescent hypothallus; columella none or small; capillitium, consisting of rather long hyaline threads, connecting the usual calcareous nodes, which are large, angular, snow-white; spore-



mass black; spores by transmitted light violet-brown, distinctly warted, about 10  $\mu$ . Plasmodium white, often with blue, green or yellow tints.

The snow-white, nearly smooth stem and the small sporangium covered with loose calcareous granules distinguish this rare species. It develops on leaves and looks like a small *Didymium squamulosum*.

Rare. Maine, Ohio, Michigan, Wisconsin, Iowa, Oregon, Colombia; Europe, South Africa, Java.

### 53. PHYSARUM LEUCOPHÆUM Fr.

Symb. Gast. 24. 1818.

Pl. V, Figs. 98, 99.

1797. *Trichia filamentosa* Trentep., in Roth, Cat. Bot. 1 : 227.

1817. *Physarum conglobatum* Ditm., in Sturm, Deutsch. Fl. Pilze 3 : 81.

1836. *Diderma terrestre* Fr. ex Weinm., Hymeno-Gastero-Myc. 574.

1882. *Physarum granulatum* Balf. fil., Grev. 10 : 115.

1884. *Physarum imitans* Racib., Rozpr. Mat.-Przyr. Akad. Krak. 12 : 73.

1892. *Physarum readeri* Massee, Mon. 282.

1893. *Tilmadoche nephroidea* Cel. fil., Myx. Böhm. 69.

1894. *Physarum nutans* Pers. var. *leucophæum* (Fr.) Lister, Mycetozoa 51.

Sporangia scattered or gregarious, stipitate; peridium globose or subdepressed, occasionally short-cylindric, 0.5–1 mm. in diameter; plano-convex, but never umbilicate below, erect, bluish ashen; stipe short, rugose, subsulcate, fuscous, brown, or sometimes almost white, even or slightly attenuate upward from a thickened base or sometimes from an indistinct hypothallus; capillitium dense, intricate; the nodules white, with comparatively little lime, thin, expanded, angular or branching; columella none; spore-mass black, spores dark violaceous, minutely roughened, about 9–11  $\mu$ .

This extremely delicate and beautiful form is certainly not to be referred to *Tilmadoche alba* (Bull.). Fries, who seems to have known of *P. compressum* A. & S., and refers it to *P. nutans* Pers., annotates the present species: "Species especially remarkable in the stipe, in the internal structure, and in its whole habit, nor is there any other with which it may be compared. . . . Peridium thin, . . . not uni-form, . . . presently breaking up into laciniate scales; at first yellow, then bluish-ashen; when empty, white. The form inconstant, globose, depressed, but never umbilicate at the base." If we may judge by what Fries says on the subject, he certainly distinguished clearly between this species and *T. alba* (Bull.), to say nothing of the stouter, larger, in every way coarser forms called by Rostafinski *P. nefroideum*, *P. compressum* and *P. lividum*.

This shadowy little species has had an eventful history, dipping in



and out of our story in most uncertain fashion. Beginning with Fries, as noted, it received confirmation at the hands of de Bary, and by Rostafinski was given priority over a long list of synonyms, and figured. The earlier English authors follow Rostafinski, but for Lister in the Mycetozoa, 51, the species becomes a synonym of *T. alba* as *P. nutans*, the description appropriately enlarged to receive it. Meantime American students generally confused it with the tilmadoches on the one hand and *P. nefroideum* Rost. (supposed) on the other. In 1897, Robert Fries in Sver. Myxom. Flora, brings the species again to view as copartner with *P. nutans*. In the Mycetozoa, 1st and 3rd editions, it appears as a variety of the same, in the 2nd edition as a subspecies.

The resemblance of *P. album* or *P. nutans* is chiefly, as intimated, a matter of definition; real differences are found in the irregular capillitium, fitting a globose sporangium, in the character of the stipe and the consequent pose. See under *P. nutans* and *P. notabile*.

If the species is to be maintained as distinct, as we believe it should be, and if *Trichia filamentosa* Trentep. is correctly regarded as synonymous, that specific name should have preference.

Widely distributed, especially in temperate regions.

#### 54. *PHYSARUM MACULATUM* Macbr.

Bull. Nat. Hist. S. U. Iowa 2 : 383. 1893.

1911. *Physarum tenerum* Rex ex Lister, Mycetozoa ed. 2. 52, in part.

Sporangia scattered or gregarious, very small, 0.3–0.4 mm., dull gray, thin-walled, dotted with minute, white calcareous granules, stipitate; stipe long, about 2 mm., stout, attenuated upward, striate longitudinally or wrinkled, filled with irregular yellow masses of lime and accordingly bright yellow in color; columella none; capillitium forming a dense net, with comparatively small yellow nodular thickenings; spores globose, purplish, each minutely papillose and displaying several scattered spots occasioned by local development of the papillæ; diameter of the spores 9–10  $\mu$ .

This species was set up for the reception of certain material collected by Professor Shimek, in 1892, in Nicaragua. It remains so far unique. The small globose sporangium mounted upon a long upwardly tapering stipe, 0.5 mm. thick below, but narrowed at the extreme base where it is lightly attached, a stem which is simply a sack stuffed with yellow lime granules;—this and the yellow capillitium are distinguishing features. The capillitium and spores suggest *Physarum viride*, but the entire habit precludes such reference. Perhaps nearest to *P. mel-leum*.

Miss Lister thinks this the same as *P. tenerum* Rex. But the whole

habit and external appearance are different; the stipe notably long, clumsy, surcharged with lime; a very singular form.

Castillo, Nicaragua.

# 55. PHYSARUM NOTABILE *Macbr.*

N. A. Slime-Moulds ed. 2. 80. 1922.

Pl. VI, Figs. 103, 104.

- 1874. *Didymium connatum* Pk., Rept. N. Y. State Mus. 26 : 74.
- 1879. *Physarum polymorphum* (Mont.) Rost. ex Peck, Rept. N. Y. State Mus. 31 : 55, *non* Rost.
- 1893. *Physarum leucophæum* Fr. ex Macbr., Bull. Lab. Nat. Hist. Iowa 2 : 156, *non* Fr.
- 1894. *Physarum compressum* Alb. & Schw. ex Lister, Mycetozoa 53, in part.
- 1896. *Physarum connexum* Lk. ex Morg., Jour. Cin. Soc. Nat. Hist. 19 : 20, in part.
- 1896. *Physarum confluens* Pers. ex Morg., Jour. Cin. Soc. Nat. Hist. 19 : 22.
- 1899. *Physarum nefroideum* Rost. ex Macbride, N. A. Slime-Moulds 41, in part.
- 1911. *Physarum connatum* (Pk.) Lister, Mycetozoa ed. 2. 71, *non* Ditm., *non* Schum.

Sporangia gregarious, sessile, stipitate, or even plasmodiocarpous; when stipitate, depressed, varying at times to irregular reniform in the same colony, or globose; peridium strongly calcareous, cinereous-white; stipe variable, generally tapering upward, always distinctly deeply plicate-furrowed throughout, in color dark, opaque, sometimes touched with white or gray, or white from a coating of calcareous granules; capillitium abundant, the white lime-knots, varying in size and shape, connected by rather long hyaline threads, with here and there an empty node; spore-mass black, by transmitted light dark, sooty brown, minutely papillose, 10–11.5  $\mu$ .

This remarkable species, while not at all difficult of recognition to one familiar with its phases, is withal very difficult to define. Normally stipitate, it often shows from the same plasmodium all sorts of forms, the shape of the fructification dependent apparently upon external conditions prevalent at the time. The amount of calcium also varies, especially in the capillitium, where there is usually much, with a tendency to the formation of something like a pseudocolumella; the outer net in such cases nearly destitute. The calcium in the stipe also varies; the black or brown stipes are, of course, free from it; the gray or white, calcareous.

Eastern United States and Canada, Brazil; Europe.

*Physarum compressum* Skvortz. *non* Alb. & Schw., Phil. Jour. Sc. 46 : 86, 1931, agrees, so far as the description goes, with some forms

of *P. notabile* except that the lime-knots are said to be dark yellow-brown.

56. *PHYSARUM PUSILLUM* (*Berk. & Curt.*) *Lister*

Mycetozoa ed. 2. 64. 1911.

Pl. VI, Figs. 105, 106.

1873. *Didymium pusillum* Berk. & Curt., Grev. 2 : 53.

1881. *Physarum nodulosum* Cke. & Balf., Rav. N. A. F. Exsic. 479. Not published.

1889. *Badhamia nodulosa* (Cke. & Balf.) Massee, Jour. Myc. 5 : 186.

1891. *Physarum calidris* Lister, Jour. Bot. 29 : 258.

1896. *Craterium nodulosum* (Cke. & Balf.) Morg., Jour. Cin. Soc. Nat. Hist. 19 : 15.

1899. *Physarum nodulosum* Cke. & Balf. ex Macbride, N. A. Slime-Moulds 51.

Sporangia gregarious, small, stipitate, globose, 0.4–0.6 mm. in diameter, grayish white at first, becoming white as the spores are freed, with a brown base, the sporangium walls thin, rugose, more or less encrusted with lime, breaking up irregularly; stipe slender, longer than the sporangium, attenuate upward or even, bright brown, rugose, merging into the shallow, cup-like base of the sporangium; columella none; capillitium with lime-knots more or less abundant, white, often uniting, somewhat badhamioid; spore-mass black; spores by transmitted light pale lilac-brown, minutely warted, 10–12  $\mu$ .

One of the smaller species of the genus, by its proportionally long stipe and small round sporangium reminding one somewhat of *P. globuliferum*; much smaller, however, and in every way different. The generic characters are mixed, and the species has been accordingly variously referred. The lower part of the peridium is sometimes persistent after the dehiscence, and in that respect suggests *Craterium*. But this character is not constant, and even at best the persisting part is very small, not greater than in *P. melleum*, for example. On the other hand, the capillitium in some sporangia is strongly calcareous, suggesting *Badhamia*, but in most sporangia the physarum characters are sufficiently clear.

The name *Physarum nodulosum* seems not to have been effectively published until 1899, although the specific name *nodulosa* was used by Massee (1889) and Morgan (1896). *Didymium pusillum* Berk. & Curt. was published in 1873. The type at Kew contains two species, this and a didymium. But Sturgis reported that the specimen in Curtis' herbarium, presumably a co-type, shows only the physarum. On the face of the record, *Physarum pusillum* (B. & C.) Lister is the valid name.

Canada to Pennsylvania and Iowa; cosmopolitan.

57. *PHYSARUM TROPICALE Macbr.*

N. A. Slime-Moulds 45. 1899.

1925. *Physarum connatum* (Pk.) Lister, Mycetozoa 3 ed. 51, in part.

Sporangia scattered, gregarious, turbinate, short-stipitate, blue-gray, about 1 mm. in diameter; peridium above iridescent, green, blue, etc., dotted with minute flecks of white, below limeless, purple or bronze, shading to the brown of the stipe; stipe short, stout, slightly rugose, cylindric, non-calcareous, brown; columella none; hypothallus none; capillitium abundant, the nodes generally calcareous, small, uniform, angular, white, uniformly distributed; spore-mass black; spores dark violet-brown, distinctly and closely warted, 12–15  $\mu$ .

A large handsome species recognizable by the peculiar turbinate sporangium, with its iridescent peridial wall in which green strongly predominates above, bronze below. The distinction between the upper and lower peridium would suggest *Craterium*, but the internal structure is not at all *Craterium*-like. The capillitium is typical of *Physarum*. The color suggests those forms of *P. leucophæum* Fr. described by Rostafinski as var. *violascens*. From this species it is at once distinguished by its much larger sporangia and larger and rougher spores.

Mexico.

58. *PHYSARUM SIMPLEX M. E. Peck*

Am. Jour. Bot. 19 : 136. 1932.

Sporangia stipitate, globose or a little depressed, minute, 0.2 to 0.3 mm. in diameter, very dark or sometimes dull yellowish; stipe 0.5 to 2 mm. long, slender, narrowed upward, irregularly grooved, often very crooked and drooping above, light yellowish, little or not at all calcareous; hypothallus none; peridium thin, often strewn with abundant flakes of lime but sometimes nearly limeless, then appearing black, persistent below; columella none; capillitium of very delicate threads springing from the peridial floor, with a few small yellowish gray calcareous nodes or none, and almost without dilations at the intersections; spores violaceous brown, minutely roughened, 7–9  $\mu$  in diameter.

A very delicate, minute species found twice in the vicinity of Salem, Oregon. It is related to *P. flavicomum* Berk., differing in the longer stipe, the more calcareous peridium and the less dense capillitium with very few calcareous nodes.

Oregon. Dead bark of *Pseudotsuga*.



59. *PHYSARUM ALBESCENS* Ellis

in Macbride, N. A. Slime-Moulds ed. 2. 86. 1922.

Pl. VI, Figs. 107, 108.

1893. *Physarum auriscalpium* Cke. ex Macbride, Bull. Lab. Nat. Hist. Iowa 2 : 158, in part.

1894. *Physarum virescens* Ditm. var. *nitens* List., Mycetozoa 59, in part.

1899. *Leocarpus fulvus* Macbr., N. A. Slime-Moulds 82.

1911. *Physarum fulvum* (Macbr.) List., Mycetozoa ed. 2. 60, non Fries.

Sporangia gregarious or scattered, ovoid or globose, occasionally subplasmodiocarpous, pale yellowish or fulvous, opening irregularly above, stipitate or sessile; peridium double, the outer layer more or less calcareous, the inner delicate, almost indistinguishable, persistent below as a shallow cup; stipe usually long, weak, striate, fulvous or yellow; hypothallus distinct, venulose or more or less continuous; capillitium pallid or white, dense, flattened and expanded at the axes, with here and there below large continuous yellow calcareous nodules; columella none; spore-mass black; spores by transmitted light dark brown, rough, 12–15  $\mu$ . The plasmodium is yellow on fallen leaves and twigs.

The capillitium is curious, largely flattened and membranous and much like that of *Leocarpus*, while the general aspect is that of a diderma. Forms occur, however, in which the capillitium is more typically physaroid; such forms may have but a single layer to the peridium. Reference to the taxonomic history will be found in N. A. Slime-Moulds, ed. 2, pp. 87–89, where the name used by Ellis, *P. albescens*, was published.

Iowa, Louisiana, Colorado, Montana, Idaho; Switzerland.

60. *PHYSARUM CITRINELLUM* Peck

Rept. N. Y. Mus. Nat. Hist. 31 : 57. 1879.

Pl. VI, Figs. 109, 110.

1869. *Diderma citrinum* Pk., Rept. N. Y. State Mus. 22 : 89, non Fr.

1894. *Craterium citrinellum* (Pk.) List., Mycetozoa 74.

Sporangia gregarious or scattered, globose, 0.6–0.8 mm. in diameter, short-stipitate, pale yellow or ochraceous, smooth or slightly roughened by the presence of minute lime particles; peridium double, the outer calcareous, fragile, the inner very delicate, with here and there a calcareous thickening, ruptured irregularly; stipe very short, half the sporangium, orange-brown, translucent, furrowed, expanded below into an imperfectly defined hypothallus; capillitium abundant, the nodes stellate-angular, large, the internodes delicate, short; spore-



mass black; spores violaceous brown by transmitted light, strongly spinulose, 10–12.5  $\mu$ . Plasmodium greenish.

A very distinct and handsome species. Easily recognizable at sight by its large, globose, almost sessile and yet distinctly stalked sporangia. The color to the naked eye is pale ochraceous or buff. Only under a moderate magnification do the citrine tints come out.

In the Twenty-second N. Y. Report Peck incorrectly referred this species to *Physarum citrinum* Schum. On the appearance of Rostafinski's Monograph, Peck changed the name to *P. citrinellum*. Under the last name the species has been generally recognized in the United States and distributed.

Eastern United States, Oregon; Germany, Rumania, Japan.

#### 61. *PHYSARUM VARIABLE* Rex

Proc. Acad. Nat. Sc. Phila. 1893 : 371.

1925. *Physarum sulphureum* Alb. & Schw. ex Lister, Mycetoza ed. 3. 26, in part.

Sporangia scattered, stipitate, substipitate or sessile, about 1 mm. high, regularly or irregularly globose, ellipsoidal, obovate or cylindric-clavate in shape; sporangium wall sometimes apparently thick, of a dingy yellow or brownish ochre color, slightly rugulose on the surface, crustaceous, brittle, rupturing irregularly, sometimes thin, translucent, covered externally with flat circular calcareous masses falling away in patches; stipes nearly equal, occasionally much expanded at the base, rough, longitudinally rugose, variable in size, sometimes one-third of a millimeter high, sometimes a mere plasmodic thickening of the base of the sporangium; color of stipes varying from a yellowish white to a dull brownish gray; capillitium a small-meshed network of delicate colorless tubules with large, many-angled, rounded masses of white, or rarely yellowish white lime granules at the nodes; no true columella, but often a central irregular mass of white lime granules; spores dark violet-brown, verruculose, 9–10  $\mu$ .

In the English monograph this is included in *P. sulphureum*; Brandza would recognize it as a variety, differing mainly in shape from typical forms of that species; Rex thought the color difference significant. What were previously regarded as sessile forms of Rex's species are now commonly referred to *P. sessile* Brandza, but Mr. Hagelstein is of the opinion that there are sessile forms of *P. variable*. In view of the uncertainty, the species may be maintained pending further information.

Rare. Pennsylvania, New York, Venezuela; Rumania.



62. *PHYSARUM CARNEUM* G. List. & Sturgis

Jour. Bot. 48 : 63. 1910.

Sporangia gregarious, stipitate, rarely sessile or forming short plasmodiocarps, subglobose, 0.5 mm. in diameter, ochraceous yellow above, flesh colored below; peridium membranous, pale yellow, lime granules evenly distributed; stipe short, translucent, pinkish flesh colored; capillitium dense, nodules white; spores purplish brown, spinulose, 8-9  $\mu$ .

Differs from *P. citrinellum* in the membranous peridium, flesh colored stalks and smaller spores.

Colorado, Montana, Washington, Oregon; Europe.

63. *PHYSARUM FLAVICOMUM* Berk.

Hooker Jour. Bot. 4 : 66. 1845.

Pl. VI, Figs. 111, 112, 113.

1873. *Physarum cupripes* Berk. & Rav., Grev. 2 : 65.1875. *Physarum berkeleyi* Rost., Mon. 105, in part.1892. *Didymium flavicomum* (Berk.) Masee, Mon. 242.

Sporangia gregarious, spherical or lenticular, small, 0.3-0.5 mm. in diameter, at first fuliginous throughout, stipitate; peridium thin, destitute of lime, iridescent, breaking up and deciduous in patches, except at the base; stipe twice the diameter of the peridium or more, golden or brown, fluted, often twisted, not hollow, tapering upward from a small but distinct, radiant hypothallus; columella none; capillitium dense, persistent, the nodes frequently calcareous, elongate and vertical, especially below, yellow; spore-mass brown; spores by transmitted light bright violaceous brown, faintly papillose, 9-10  $\mu$ .

This species is instantly distinguishable from all cognate forms by its peculiar sooty color. Not less is the species structurally marked by its capillitium. The latter below is exactly as in the species formerly referred to Tilmadoche. Indeed, the present species unites characters supposed to distinguish *Physarum* from *Tilmadoche*, and thus justifies those who bring all the species of both genera together under one generic name. In any case the species is by its capillitium entirely distinct from *P. galbeum*, as well as by the structure of the stipe and the peridial surface. The plasmodium, at first watery, emerges from decayed elm logs and soon takes on a peculiar greenish tint preserved somewhat in the mature fruit.

Rostafinski (Monograph 105, 106), rejects Berkeley's specific name, *flavicomum*, because it refers to the somewhat indefinite color. As

this is no valid reason for change, we retain Berkeley's specific name, which by general consent has priority.

Not common. New Jersey, South Carolina, Ohio, Minnesota, Iowa; reported from South Africa, Java, Japan, Australia, New Zealand.

64. *PHYSARUM SULPHUREUM* *Alb. & Schw.*

Consp. Fung. 93. 1805.

Pl. VI, Figs. 114, 115.

1818. *Physarum flavum* Fr., Symb. Gast. 22.

1877. *Physarum sulphureum* Alb. & Schw. ex Cooke, Ann. Lyc. Nat. Hist. N. Y. 11 : 384.

Sporangia gregarious, subglobose, rugulose-squamulose, 0.6–0.8 mm., sulphur-yellow, stipitate; peridium membranous, covered with calcareous scales; stipe stout, white, charged with lime, furrowed; columella none; capillitium strongly calcareous, the nodules large, white; spores violaceous, rough, 9–11  $\mu$ . Plasmodium yellow.

The description and figure given by Schweinitz, 1805, leave no doubt as to what he had in hand. Twenty or thirty years later, having spent the interval in this country—bishop, indeed, of the Moravian churches, but a student of fungi all the while—he reports the same thing from this country. Cooke also lists it in *Myxomycetes* of the United States.

Eastern United States to Wisconsin and Iowa, rare, South America; Europe, Japan.

65. *PHYSARUM AURISCALPIUM* *Cooke*

Ann. Lyc. Nat. Hist. N. Y. 11 : 384. 1877.

Pl. VI, Figs. 116, 117.

1898. *Physarum auriscalpium* Cooke ex Lister, Jour. Bot. 36 : 115.

1899. *Physarum auriscalpium* Cooke ex Macbride, N. A. Slime-Moulds 38.

1911. *Physarum auriscalpium* Cooke ex Lister, Mycetozoa ed. 2. 60, in part.

Cooke's original description is as follows:

"Sporangia globose, depressed, ochrey yellow, covered with orange mealy scales above, with a very short, almost obsolete, stem. Columella not evident. Capillitium strongly developed, expanded at the angles, which are filled with yellow granules of lime, combined into a network; deposits of lime in irregular, angular masses. Spores violet-brown, nearly smooth or minutely warted, .013–.015 mm. diam."

Reference is made to fig. 253 of the same author's *Myxomycetes* of Great Britain, which merely indicates the depressed globose peridium with a tendency for the lower portion to remain as a cup, and the short, thick stipe. The species is not mentioned in the text. The spores

rarely exceed  $12\mu$  in our material, and mostly range from  $9-11\mu$ . Cooke's specimens, originally collected by Ravenel in (South?) Carolina are still preserved in London.

Rare in the United States: Reported from Massachusetts, New York, "Carolina," Wisconsin, Iowa, Colorado, Montana, Oregon, California; Europe. Reported from South America, South Africa, southern Asia and Japan, but most reports are probably more than questionable.

#### 66. *PHYSARUM TENERUM* *Rex*

Proc. Acad. Nat. Sc. Phila. 1890 : 192.

Pl. VI, Figs. 118, 119.

1899. *Physarum ohrusseum* (Berk. & Curt.) Rost. ex Macbride, N. A. Slime-Moulds 52, *non* Rost.

Sporangia stipitate, spherical, erect or nodding,  $0.3-0.4$  mm. in diameter; peridium single, membranous, but thickly studded with circular, flattened, yellow granules of lime, dehiscing by petal-like lobes; stipe  $1-1.5$  mm. long, subulate, slender, opaque, striate and dark below, pale yellow above; columella none; capillitium delicate, of yellow, rounded nodes, connected by hyaline threads, many of the intersections limeless; spores dark brown, delicately warted,  $7-8\mu$ . Plasmodium yellow.

This delicate *Physarum*, very fragile and evanescent, seems to be distinct, by reason of its characteristic rounded nodules, from any similar stipitate species. It resembles *P. citrinum*, but is more slender, the color is grayish yellow, and it lacks a columella. It varies a little according to locality. Ohio specimens are a little larger and have thicker and more calcareous stipes than is usual in those from Philadelphia. The walls of the sporangia when fully matured generally break into several petal-like segments which finally become reflexed.

Rare. New Jersey, Pennsylvania, Virginia, Ohio, Louisiana, Iowa, Texas, Montana, Washington, West Indies, South America; Portugal, Rumania, Ceylon, Malay Peninsula, Java, Japan.

#### 67. *PHYSARUM GALBEUM* *Wingate*

in Macbride, N. A. Slime-Moulds 53. 1899.

Pl. IV, Fig. 64.

1890. *Physarum galbeum* Wing., Ellis N. A. F. 2491, without description.

1892. *Physarum petersii* Berk. & Curt. ex Massee, Mon. 295, in part.

1894. *Physarum berkeleyi* Rost. ex List., Mycetozoa 47, in part.

Sporangia scattered, globose,  $0.4-0.5$  mm. in diameter, stipitate, often nodding, golden yellow, peridium exceedingly thin, breaking up



into patches on which the yellow lime granules are conspicuous; stipe non-calcareous, pale brown or amber colored, longitudinally wrinkled, about one and one-half times the diameter of the peridium; columella none; hypothallus none; capillitium dense, of extremely delicate yellow threads, the nodes only here and there calcareous, the lime-knots, when present, small, angular, yellow; spore-mass pale brown; spores almost smooth, lilac- or violet-tinted,  $7.5-10\ \mu$ .

Distinguished among the small delicate species with which it will be naturally associated, by the yellow, richly calcareous wall of the globose sporangium and the almost limeless capillitium. The stipe is hollow and contains irregular masses of refuse granular matter, but no lime so far as we have been able to discover. *P. flavicomum*, to which the species is related most closely, differs in having the wall non-calcareous, iridescent, as well as in the color throughout; in the character of the capillitium, in which lime is abundant; and in the absence of refuse matter in the stem.

Nova Scotia, Vermont, Pennsylvania, Iowa, Minnesota; Europe, Ceylon.

#### 68. PHYSARUM OBLATUM *Macbr.*

Bull. Nat. Hist. S. U. Iowa 2 : 384. 1893.  
Pl. VI, Figs. 120, 121.

1896. *Craterium maydis* Morg., Jour. Cin. Soc. Nat. Hist. 19 : 15.

1909. *Physarum maydis* (Morg.) Torr., Fl. Myx. 193.

Sporangia gregarious, stipitate, small, bright yellow, globose or depressed-globose, rough; stipe reddish brown or fuliginous, even, short, slender; hypothallus scant, black, or none; columella none; threads of the capillitium hyaline or yellowish, delicate, connecting the rather dense and abundant irregular yellow nodes; spore-mass brownish black, spores violaceous, minutely but distinctly spinulose,  $9-11\ \mu$ .

This species is easily recognizable by its brilliant yellow color, somewhat rugose, sometimes scaly peridium, its richly calcareous capillitium, also bright yellow where not weathered or faded, and its dark brown, translucent, non-calcareous stem. After dehiscence, the base of the peridium often persists as a cup. This circumstance, with the fact that decaying maize-stalks and leaves are a favorite habitat, led Professor Morgan to its description as *Craterium maydis*. But it is doubtless a physarum, occurring on habitats of all sorts.

Ohio to Iowa, Colorado and Washington, West Indies; Germany, Rumania, Uganda, Java.



69. *PHYSARUM GYROSUM* Rost.

Mon. 111. 1875, in part.

Pl. VI, Figs. 123, 124.

1892. *Physarum cerebrinum* Massee, Mon. 306.1902. *Fuligo gyrosa* (Rost.) Jahn, Ber. Deutsch. Bot. Ges. 20 : 272.

Sporangia yellowish gray or pinkish gray, gyrose, irregular, often forming dense, venulose, laterally compressed plasmodiocarps, sometimes subæthalioid, usually sessile upon a common strongly developed hypothallus; sometimes isolated and irregularly globose, or with a slender, dull red stalk formed by a strand of the hypothallus; capillitium delicate, the nodules elongate, variable in size; spores pale violaceous brown, minutely spinulose, 7–10  $\mu$ . Plasmodium yellowish white.

The present conception of this species is that of Jahn rather than that of Rostafinski, although Jahn placed it in the genus *Fuligo*, to which, indeed, it bears much resemblance. Rostafinski seems to have included under this name not only the present species, but also *Fuligo muscorum* and certain plasmodiocarpous phases of *Physarella oblonga*.

The species suggests a large, sessile form of *Physarum polycephalum* but is distinct.

Widespread, reported from every continent, but not very common as a rule. In North America recorded from New York, Pennsylvania, District of Columbia, Virginia, Mississippi, Iowa.

70. *PHYSARUM POLYCEPHALUM* Schw.

Schr. Naturforsch. Ges. Leipzig 1 : 63. 1822.

Pl. VI, Fig. 122.

1829. *Didymium polycephalum* (Schw.) Fr., Syst. Myc. 3 : 122.1837. *Didymium polymorphum* Mont., Ann. Sc. Nat. 2 ser. 8 : 361.1837. *Didymium gyrocephalum* Mont., Ann. Sc. Nat. 2 ser. 8 : 362.1869. *Didymium obrusseum* Berk. & Curt., Jour. Linn. Soc. 10 : 348.1869. *Didymium tenerrimum* Berk. & Curt., Jour. Linn. Soc. 10 : 348.1875. *Physarum polymorphum* (Mont.) Rost., Mon. 107.1875. *Tilmadoche gyrocephala* (Mont.) Rost., Mon. 131.1876. *Physarum obrusseum* (Berk. & Curt.) Rost., Mon. App. 11.1884. *Physarum multiplex* Pk., Bull. Torrey Bot. Club 11 : 50.1899. *Tilmadoche polycephala* (Schw.) Macbr. N. A. Slime-Moulds 57.

Sporangia spherical or irregular, gyrose-confluent, helvelloid, umbilicate below; peridium thin, ashy, covered with evanescent yellow squamules, fragile; stipe from an expanded membranaceous base, long-subulate, yellow; spores minutely spinulose, violet, 9–11  $\mu$ . Plasmodium yellow.

A most singular and well-defined species, occurring in masses of

decaying leaves or on rotten logs. The plasmodium, at first colorless, as it emerges for fructification becomes white, then yellow, spreading far over all adjacent objects, not sparing the leaves and flowers of living plants; at evening, slime, spreading, streaming, changing; by morning, fruit, a thousand stalked sporangia with their strangely convoluted sculpture. The evening winds again bear off the sooty spores, and naught remains but twisted yellow stems crowned with a pencil of tufted silken hairs.

Although Rostafinski's description of this species is accurate and marks exactly a tilmadoche and is very different from his description of *Physarum polymorphum*, nevertheless it is probable that both descriptions have reference to the same thing. All specimens on which both species were based were American; *P. polymorphum*, North American. But the only North American form to which reference can be made is that called by Schweinitz *P. polycephalum* and, fortunately, sufficiently described. Furthermore, Rostafinski, under *T. gyrocephala*, himself affirms the probable identity of Montagne's *Didymium gyrocephalum* with the Schweinitzian species, and uses Montagne's specific name provisionally. For these reasons it seems proper to write the species as above.

This species is so common that its plasmodium and fructification may be easily observed. Professor Morton E. Peck says of *P. polycephalum*: "In one instance I observed a plasmodium for twelve successive days on the surface of a decaying stump. During this period it crept all around the stump and from top to bottom several times. At one time the color was bright yellow; at another, greenish yellow; and once, shortly before fruiting, it became clear bright green. A heavy rain fell upon the plasmodium but it appeared to sustain little injury and ultimately developed normal sporangia." The plasmodium feeds largely on the hymenium of various fleshy and subfleshy fungi, and may readily be cultured on such substrata. See Howard (1931).

The var. *obrusseum* (Berk. & Curt.) List. is merely a phase with the sporangia more or less free instead of united. It seems to merge imperceptibly into the other forms.

Widely distributed and common, from Maine and Canada to Washington and south to Nicaragua, Puerto Rico, British Guiana; France, Rumania, Malay Peninsula, Japan.

#### 71. *PHYSARUM DICTYOSPERMUM* List.

Jour. Bot. 43 : 112. 1905.

Sporangia subglobose, short-stalked, erect, scattered, 0.5–0.6 mm. in diameter, dull orange, dark chestnut or olive-brown, glossy, spo-

rangium wall membranous, rather firm, orange; stalk 0.1–0.7 mm. high, slender, black, enclosing refuse matter, sometimes yellow above from superficial lime granules; columella black, conical or clavate, short to two-thirds the height of the sporangium; capillitium abundant, persistent, of colorless threads with small, fusiform, orange-red nodes; spores pale purplish gray, reticulated, five to six meshes on one side, meshes fainter and less regular on the other, sometimes marked merely by short curved lines, 10–11  $\mu$ .

The above description is slightly abridged from Lister, 3rd edition, 35. It is suggested that its relationships are with *P. psittacinum* because of the orange nodes and peridial deposits. The capillitium, however, is decidedly tilmadochoid as described.

Chile; Switzerland, New Zealand, Australia.

## 72. *PHYSARUM NUTANS Pers.*

Ust. Ann. Bot. 15 : 6. 1795.

Pl. VI, Figs. 125, 126.

- 1791. *Sphaerocarpus albus* Bull., Champ. 137.
- 1791. *Stemonitis alba* (Bull.) Gmel., Syst. Nat. 2 : 1469.
- 1797. *Trichia nutans* (Pers.) Trentep., in Roth, Cat. Bot. 1 : 227.
- 1803. *Trichia cernua* Schum., Enum. Pl. Sæll. 2 : 241.
- 1829. *Physarum cernuum* (Schum.) Fr., Syst. Myc. 3 : 130, in part.
- 1829. *Didymium marginatum* Fr., Syst. Myc. 3 : 115.
- 1829. *Didymium furfuraceum* Fr., Syst. Myc. 3 : 116.
- 1829. *Physarum gracilentum* Fr., Syst. Myc. 3 : 133.
- 1849. *Tilmadoche cernua* (Schum.) Fr., Summ. Veg. Scand. 454.
- 1873. *Tilmadoche nutans* (Pers.) Rost., Versuch 10.
- 1875. *Tilmadoche gracilenta* (Fr.) Rost., Mon. 129.
- 1899. *Tilmadoche alba* (Bull.) Macbr., N. A. Slime-Moulds 58.

Sporangia gregarious, depressed-spherical, 0.4–0.7 mm. in diameter, sometimes smaller, stipitate, umbilicate, gray or white, thin-walled, erect or nodding; stipe long, tapering upward, brown or black below, ashen white above, lightly striate, graceful; capillitium abundant, threads delicate, intricately combined in a loose persistent network with occasional minute, rounded, or elongate white calcareous nodules; spores minutely roughened, globose, about 10  $\mu$ .

The nodding, lenticular, umbilicate sporangium, barely attached to the apiculate stipe, is sufficient to distinguish this elegant little species, recognized and quite aptly characterized by mycologists for more than one hundred years. The stipe is usually white above, fuscous below, at the apex almost evanescent; hence the cernuous sporangia. The same character is less strikingly manifest in the species next following.

The plasmodium is bright yellow, sometimes greenish. Brought in

from the field and maturing under a bell-jar, the color changes to a watery white just before the sporangia rise in fruit.

As *Sphaerocarpus albus*, Bulliard first prescribed the limits by which the species is at present bounded. The description by Fries (Syst. Myc. 3 : 128) is especially graphic: "Peridium very thin, in form quite constantly lenticular, umbilicate at base, at first smooth, then uneven, generally laciniate-dehiscent, the segments persistent at least at base." *Physarum album* Fr. (Syst. Myc. 3 : 147) is regarded as a synonym of *Didymium difforme* and should not be revived for a different species, hence Persoon's name, generally accepted, should stand. *P. album* Fuckel (Rhen. Fl. No. 1469, 1865), is believed to be *P. cinereum*.

Var. *robustum* Lister is applied to an erect, sometimes plasmodiocarpous form, often exhibiting a pseudocolumella.

Common and world-wide in distribution.

### 73. PHYSARUM VIRIDE (Bull.) Pers.

Usteri Ann. Bot. 15 : 6. 1795.

Pl. VI, Figs. 127, 128.

1791. *Sphaerocarpus viridis* Bull., Champ. 135.

1791. *Sphaerocarpus luteus* Bull., Champ. 136.

1791. *Stemonitis viridis* (Bull.) Gmel., Syst. Nat. 2 : 1469.

1794. *Physarum aureum* Pers. in Roemer, Neu. Mag. Bot. 1 : 88.

1829. *Physarum nutans* var. *viride* Fr., Syst. Myc. 3 : 129.

1829. *Physarum nutans* var. *aureum* Fr., Syst. Myc. 3 : 129.

1875. *Tilmadoche mutabilis* Rost., Mon. 129.

1880. *Tilmadoche viridis* (Bull.) Sacc., Michelia 2 : 263.

Sporangia globose, flattened or lenticular, 0.3–0.5 mm., plane or concave below, variously colored—yellow, greenish yellow, rusty orange—stipitate, nodding; the peridium splitting irregularly or reticulately; stipe subulate, variable in length and color, through various shades of yellow and red to black; capillitium strongly developed, concolorous with sporangium, the colorless tubes connecting the yellow or orange fusiform nodes; spores smooth, fuscous or violet-black, 7–9  $\mu$ . Plasmodium yellow to yellow-green.

A very handsome and common little species; like the preceding, but generally greenish yellow in color, and occasionally brilliantly orange without a suggestion of green. Indeed, the color is so variable that some authors have been disposed to discard the species entirely, inasmuch as the chief specific character is color.

The following varieties may be recognized:

Var. *aurantium* (Bull.) Lister, Mycetozoa 47, 1894 (*Sphaerocarpus aurantius* Bull., 1791; *Stemonitis aurantia* (Bull.) Gmel. 1791; *Physarum aurantium* (Bull.) Pers., 1801; *Trichia aurantia* (Bull.) DC.,



1805; *Physarum nutans* var. *coccineum* Fr., 1829; *Physarum striatum* var. *aurantiacum* Fr., 1829). This is a bright orange phase, arising from an orange plasmodium. Brandza, who would restrict *P. viride* to delicate yellow forms with long slender stalks and fusiform yellow nodes, notes that the two forms never occur together and believes that they represent distinct species. Common.

Var. *incanum* Lister, Mycetoza 47, 1894 (*Stemonitis bicolor* Gmel., 1791; *Physarum luteum* Pers. 1801; *Trichia lutea* DC., 1805). Yellowish gray, with pale yellow nodes. Common.

Var. *hinnuleum* G. List., Jour. Bot. 62 : 17, 1924, from India, is described as with fawn colored sporangia and nodes and buff spores. Common and world-wide in its distribution.

#### 74. *PHYSARUM BETHELII* (Macbr.) List.

Mycetoza ed. 2. 57. 1911.

1899. *Tilmadoche bethelii* Macbr. in litt.

1913. *Physarum viride* Pers. var. *bethelii* Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 439.

Sporangia scattered, globose, umbilicate below, 0.5–1 mm. in diameter, iridescent-blue, or sometimes tinged by the presence of delicate pale yellow calcareous scales, stipitate; stipe rather short, black or dark brown, equal; capillitium dense, radiating from the black, slightly intrusive summit of the stipe, and ascending from the base of the peridium; the nodules not numerous, elongate, branching betimes, pale yellow; spores minutely roughened, 10–12  $\mu$ . Plasmodium yellow.

Both Miss Lister and Mr. Hagelstein agree with Dr. Sturgis in considering this merely a variety of *P. nutans*. Doctor Brandza believes it distinct. The material at hand seems sufficiently distinct to justify retaining it, pending fuller information.

This beautiful, delicately tinted little species is clearly tilmadochoid in the Friesian sense. The capillitium persists after the fall of the upper filmy peridium, adherent below to the persisting peridial base. Collected thus far only by Professor Bethel and by Professor Sturgis, Colorado, by Mr. Hagelstein in Long Island and by Professor Brandza in Rumania.

#### 75. *PHYSARUM RIGIDUM* G. Lister

Mycetoza ed 3. 36. 1925.

1911. *Physarum viride* Pers. var. *rigidum* Lister, Mycetoza ed. 2. 56.

Sporangia gregarious, stalked, lenticular, often umbilicate above, yellow, dull orange or iridescent from absence of lime granules; stalk slender, orange or yellow above, dark below from included refuse



matter, 0.3–1.5 mm. high; capillitium of sparingly branched threads or flattened tubes with long narrow orange lime-knots, or consisting almost entirely of slender, rod-like tubes enclosing yellow lime granules; spores rich violet-brown, minutely spinulose, 9–12  $\mu$ . Plasmodium yellow.

The above description, based on that of Miss Lister, as well as the fact that the species was formerly regarded as a variety of *P. viride*, seems to justify placing it tentatively with the tilmadoches.

Reported from the West Indies; Central Africa, Malay Peninsula, Japan.

### 5. *Craterium Trentepohl*

in Roth, Cat. Bot. 1 : 224. 1797.

Sporangia stalked, cyathiform, the peridium of two or three layers, the dehiscence more or less definitely circumscissile, or by a distinct lid, the upper portions calcareous, the lower cartilaginous, long-persistent as a cup containing the spores and capillitium, the nodes of the latter often aggregated to form a pseudocolumella.

Very close to *Physarum*, from which genus it is separated by the form of the sporangia and the method of dehiscence. In some forms there is a tendency to irregular dehiscence, notably in *C. leucocephalum* var. *scyphoides*, but even here approximately half the sporangium wall remains as a persistent cup. The capillitium is occasionally badhamioid.

#### KEY TO THE SPECIES OF CRATERIUM

- |   |                            |
|---|----------------------------|
| a. Dehiscence circumscissile or by the breaking up of the upper wall of the sporangium..... | b                          |
| a. Dehiscence by a distinct lid.....  | d                          |
| b. Sporangia violet or purple.....  | 1. <i>C. paraguayense</i>  |
| b. Sporangia yellow.....  | 2. <i>C. aureum</i>        |
| b. Sporangia white-capped.....  | c                          |
| c. Sporangia subglobose to obovoid.....   | 3. <i>C. leucocephalum</i> |
| c. Sporangia elongate, cylindrical.....   | 4. <i>C. cylindricum</i>   |
| d. Capillitium entirely white.....  | 5. <i>C. minutum</i>       |
| d. Lime-knots pale brown, small.....  | 6. <i>C. concinnum</i>     |
| d. Lime-knots pinkish or reddish brown, some large.....                                     | 7. <i>C. rubronodum</i>    |

### 1. *CRATERIUM PARAGUAYENSE* (Speg.) List.

Mycetozoa ed. 2. 95. 1911.

Pl. VI, Figs. 129, 130.

1883. *Didymium paraguayense* Speg., Fung. Guar. Pug. 1 : 141.

1893. *Craterium rubescens* Rex, Proc. Ac. Nat. Sc. Phila. 370.

1904. *Iocraterium rubescens* (Rex) Jahn, Hedwigia 43 : 302.

1909. *Iocraterium paraguayense* (Speg.) Torrend, Fl. Myx. 174.

Sporangia gregarious, cylindrical or elongate-cyathiform, stipitate, dark violet-red, the apex slightly roughened by pale calcareous granules, the peridium longitudinally wrinkled below; dehiscence irregularly circumscissile; stipe darker, one-half the height of the sporangium, longitudinally wrinkled; capillitium dense, abundantly calcareous; spores violet-brown, minutely roughened, 8-9  $\mu$ .

In form resembling the following species, but instantly distinguished by the color, which is red throughout, tinged with purple or violet. The capillitium is badhamioid, as noted by Dr. Rex. Very distinct from *Physarum newtoni* in color, form, habit, epispore, etc.

Iowa, Louisiana, Paraguay, Brazil.

## 2. CRATERIUM AUREUM (Schum.) Rost.

Mon. 124. 1875.

Pl. VI, Figs. 131, 132; Pl. XXI, Figs. 570, 571.

1803. *Trichia aurea* Schum., Enum. Pl. Sæll. 2 : 207.

1829. *Craterium mutabile* Fries, Syst. Myc. 3 : 154, non Symb. Gast. 19, 1818.

1844. *Cupularia mutabilis* (Fr.) Rabenh., Deutsch. Krypt.-Fl. 1 : 271.

Sporangia gregarious, globose or obovoid, 0.4-0.6 mm. in diameter, stipitate, golden yellow, erect, the peridial wall thin, especially at the summit, where at maturity it breaks up somewhat reticulately, leaving the persistent lower portion with an uneven margin above which projects the pale yellow capillitium; stipe short, orange or brownish red, arising from a small hypothallus; capillitium dense, yellow, the nodules not large, irregular, tending to form a pseudocolumella in the center of the cup; spores minutely warted, violaceous brown, 8-10  $\mu$ .

Fries regarded this, which he called *C. mutabile*, the most distinctly marked species of the genus; chiefly, as it appears, on account of the bright yellow color. This, however, varies. Some specimens before us are gray, showing only a trace of yellow below. In some European specimens a reddish tinge prevails. The form of the sporangium also varies. In typical specimens, unopened, the shape is almost pyriform; opened, we have a cylindric, oftenest lemon-yellow vase, mounted on a short striate stalk. But again, from the same plasmodium, we may have globose sporangia, opening so as to leave only a shallow, salver-shaped base. In this case the stipe is also longer. The plasmodium is said to be "clear lemon yellow" (Masse).

There seems little doubt that Schumacher had in mind the present species in his *Trichia aurea*. Rostafinski shows that Fries' synonym, *C. mutabile*, is founded on a mistake. The earlier specific name is therefore on Rostafinski's authority adopted.

Not common. New York, New Jersey, Pennsylvania, North Caro-

lina, Ohio, Iowa, Colorado, Washington, California; Europe, Asia, Africa.

### 3. CRATERIUM LEUCOCEPHALUM (Pers.) Ditm.

in Sturm, Deutsch. Fl. Pilze : 121. 1813.

Pl. VII, Figs. 133, 134, 135.

- 1791. *Stemonitis leucocephala* Pers. in Gmel., Syst. Nat. 2 : 1467.
- 1795. *Arcyria leucocephala* (Pers.) Hoffm., Fl. Crypt. Germ. 2, pl. 6, fig. 1.
- 1821. *Cyathus cinereus* Purton, Midl. Flora 3 : 309.
- 1833. *Cupularia leucocephala* (Pers.) Link, Handb. Gewach. 3 : 421.
- 1833. *Craterium xanthopus* Wallr., Fl. Crypt. Germ. 2 : 358.
- 1836. *Craterium deoperculatum* Fr. in Weinm., Hymen. & Gast. 597.
- 1844. *Cupularia xanthopus* (Wallr.) Rabenh., Deutsch. Krypt.-Fl. 1 : 271.
- 1889. *Physarum scyphoides* Cke. & Balf. ex Massee, Jour. Myc. 5 : 185.
- 1892. *Craterium fuckelii* Massee, Mon. 272.
- 1896. *Craterium convivale* (Batsch) Morg., Jour. Cin. Soc. Nat. Hist. 19 : 14.

Sporangia gregarious, short-cylindric or ovate, pure white above, brown or reddish brown below, stipitate, occasionally sessile and somewhat plasmodiocarpous, dehiscence irregularly circumscissile, the persistent portion of the peridium beaker-shaped; stipe short, stout, expanded above into the base of the peridium, with which it is concolorous; hypothallus scant; capillitium white or sometimes, toward the center, brownish, the calcareous nodules large, conspicuous, and persistent; spore-mass black; spores violaceous brown, minutely spinulose, 8-9  $\mu$ .

Distinguished by its white cap from all except the next, from which the markedly different form serves as the diagnostic feature. In some gatherings, curious patches of yellow mark the otherwise snow-white cap and sides; these are mere stains, or sometimes definite, crystalline, flake-like bodies, standing out in plain relief on the sporangial wall, or lurking in the larger nodules which are massed along the axis of the cup to form the pseudocolumella here strongly developed. Mr. Lister calls attention to these yellow flakes, and regards them as diagnostic. European specimens often show the capillitium more or less yellow, sometimes throughout.

The nomenclature question is here somewhat difficult. Fries heads his list of synonyms with *Peziza convivalis* Batsch. Batsch simply described Micheli's figure. Now there is nothing in Micheli's figure (pl. 86, fig. 14) to enable one to say with certainty which craterium Micheli had in mind, if a craterium at all. Nor does Batsch help the matter when he offers the description following: "Stipitata; acute-conica, patens; stipite subdistincto, lineari, brevi, valido. *Albicans*. *In foliis hederæ putridis*." There is nothing definitive here but the one

word "albicans" quoted from Micheli. But this term is applicable rather to *C. minutum*, the cups of which whiten with weathering. It may be, as insisted by Fries (Syst. Myc. 3 : 149), that Micheli drew crateriums; but if so, we cannot determine which species.

The specific name here adopted was applied by Persoon probably to this form; but Persoon likewise failed to distinguish the present species from *C. minutum* (see Syn. Meth. Fung., pp. 183, 184, and Fries op. cit., p. 153). Ditmar leaves no doubt as to what he figures and describes, and accordingly the name he first correctly uses is here adopted.

The var. *cylindricum* of Lister is here regarded as a distinct species. The variety *rufum* G. List. is entirely brownish red. Var. *scyphoides* List. has turbinate or globose sporangia, the entire upper half falling away irregularly in dehiscence. The var. *inclusum* Cel. fil. (Myx. Böhm. 79), with sporangia clustered on a common stalk, is reported from central Europe.

Common. New England and Ontario to North Carolina, Washington and California, Brazil, Bolivia, Argentina. Common in Europe and in the old world generally.

#### 4. CRATERIUM CYLINDRICUM *Massee*

Mon. 268. 1892.

Pl. VII, Figs. 136, 137.

1894. *Craterium leucocephalum* (Pers.) Ditm. ex Lister, Mycetozoa 72, in part.

1911. *Craterium leucocephalum* (Pers.) Ditm. var. *cylindricum* List., Mycetozoa ed. 2. 97.

Sporangia gregarious, 0.5 mm. in diameter or less, slender, cylindric, almost entirely white, stipitate; peridium delicate, transparent although calcareous nearly to the base, opening by a dehiscence regularly circumscissile; stipe short, about one-third the total height, clear orange-brown, somewhat furrowed, rising from an indistinct hypothallus; capillitium very lax, physaroid, the calcareous nodules large, rounded, pure white, aggregated at the center of the cup and often forming a conspicuous pseudocolumella; spore-mass black; spore minutely roughened to practically smooth, violaceous brown, 8-9  $\mu$ .

Lister includes this species with *C. leucocephalum*, from which its more delicate structure and cylindrical shape certainly distinguish it. The dehiscence is even more regular than in the preceding species and approaches that of *C. minutum*, with bleached forms of which it must not be confused.

*C. minimum* Berk. & Curt., Grev. 2 : 67, 1873, has here priority, but Massee regards this name as indicating a distinct species. We



have been unable to determine what the authors really had before them, and adopt accordingly the first available combination.

New England and Ontario to Iowa and south; reported also from Moldavia, Japan and the oriental tropics.

### 5. CRATERIUM MINUTUM (*Leers*) *Fr.*

Syst. Myc. 3 : 151. 1829.  
Pl. VII, Figs. 138, 139, 140.

- 1775. *Peziza minuta* Leers, Fl. Herborn. 277.
- 1787. *Cyathus minutus* (Leers) Hoffm., Veg. Crypt. 6.
- 1797. *Craterium pedunculatum* Trent., in Roth, Cat. Bot. 1 : 224.
- 1803. *Physarum turbinatum* Schum., Enum. Pl. Sæll. 2 : 205.
- 1803. *Physarum pedunculatum* (Trent.) Schum., Enum. Pl. Sæll. 2 : 205.
- 1813. *Craterium vulgare* Ditmar, in Sturm, Deutsch. Fl. Pilze 17.
- 1813. *Craterium pyriforme* Ditmar, in Sturm, Deutsch. Fl. Pilze 19.
- 1829. *Craterium nudans* Fr., Syst. Myc. 3 : 151.
- 1829. *Craterium turbinatum* (Schum.) Fr., Syst. Myc. 3 : 152.
- 1875. *Craterium ærstedtii* Rost., Mon. 120.
- 1875. *Craterium friesii* Rost., Mon. 122.
- 1892. *Craterium confusum* Massee, Mon. 263.

Sporangia scattered, gregarious, cyathiform or turbinate, grayish brown or yellow, stipitate, the peridial wall rather thick, double, opening by a distinct lid which lies usually below the slightly thickened and everted margin of the cup; stipe paler, translucent, about equalling in height the peridial cup, longitudinally wrinkled, with hypothallus scant or none; capillitium physaroid, the calcareous nodules large, white, and generally aggregated at the center of the cup; spore-mass black, spores by transmitted light violaceous, minutely warted, 8–10  $\mu$ . Plasmodium bright yellow to orange.

This is the most highly differentiated of the whole series. The cup is shapely and well defined, while the lid is not only distinct, but is a thin, delicate membrane of slightly different structure when compared with the peridial wall. It is in most material before us depressed below the mouth of the sporangium. The whole structure in such specimens corresponds with Fries' description of *C. pedunculatum* Trent., while specimens received from Europe correspond to Fries' account of *C. minutum* Leers. Nevertheless we are assured that the two forms are in Europe developed from the same plasmodium, and therefore adopt the earlier specific name as above. This is probably *Peziza convivalis* of Batsch and Micheli. Miss Currie reports the yellow phase from Toronto and we have a number of yellow gatherings from Europe.

Common throughout the eastern United States and Canada, west to Oregon and Washington, and south to Louisiana; cosmopolitan.



6. CRATERIUM CONCINNUM *Rex*

Proc. Acad. Nat. Sc. Phila. 1893 : 370.

Sporangia scattered, usually minute, broadly funnel-shaped, stipitate, peridium simple, variously colored by innate lime granules, opening by a regular cap or operculum, brownish white, darkest in the center, always more or less convex; stipe equalling the cup in height, dark brown, longitudinally ridged; capillitium a close-meshed network, with small rounded or slightly angular masses of ochre-brown lime granules, larger toward the center; spores pale brown, minutely warted, 9-10  $\mu$ .

This species differs from *C. minutum*, with which it seems most nearly allied, in form, color, capillitium and color of spores. In habitat, however, it seems no less distinct, being found mostly on the spines of decaying chestnut-burs lying on the ground, in company with that other peculiar species *Lachnobolus globosus*.

Eastern United States; Japan.

7. CRATERIUM RUBRONODUM *G. Lister*

Trans. Brit. Myc. Soc. 5 : 74. 1915.

1913. *Badhamia rubiginosa* (Chev.) Rost. var. *concinna* G. Lister in Minakata, Bot. Mag. Tokyo 27 : 408.

Sporangia gregarious, stalked, goblet- or saucer-shaped, 0.2-0.6 mm. in diameter, smooth, pearl gray with red-brown base; lid convex or nearly flat, with an upturned rim, white or pinkish gray, smooth; sporangium wall somewhat cartilaginous, pinkish gray with uniform deposits of lime granules, studded on the inner side with many small pouches containing lime; stalk dark red-brown, slender, 0.1-0.2 mm. high, arising from a discoid hypothallus; capillitium of ovoid or irregular, rounded pale pink lime-knots, dark red-brown by transmitted light, connected by hyaline threads, usually forming a large central solid or hollow pseudocolumella; spores purplish gray, echinulate or imperfectly reticulate, 10-12  $\mu$ . Plasmodium primrose yellow, then orange.

The above description abridged slightly from Lister, ed. 3.  
Japan, India.

6. *Trichamphora Jungh.*

Fl. Crypt. Jav. 12. 1838.

Sporangia discoidal, concave above, saucer-shaped, stipitate; peridium membranous, more or less encrusted with lime; capillitium

colorless, with many or few lime-knots, sometimes almost badhamioid, at other times limeless and in this respect approaching *Didymium*.

Rather artificially separated from *Physarum*, mainly on the basis of the broad, saucer-shaped sporangium, mounted on a stalk. Unlike *Physarella* in shape and lacking the characteristic trabeculae of that genus.

A single species:

*TRICHAMPHORA PEZIZOIDEA* *Jungh.*

Fl. Crypt. Jav. 12. 1838.

Pl. VII, Figs. 141, 142.

- 1854. *Didymium zeylanicum* Berk., Hook. Jour. Bot. 6 : 230.
- 1869. *Physarum macrocarpum* Fuckel, Symb. Myc. 343.
- 1873. *Trichamphora fuckeliana* Rost., in Fuckel, Symb. Myc., Nachtr. 71.
- 1875. *Chondrioderma pezizoides* Rost., Mon. 424, pl. 8, fig. 122.
- 1876. *Badhamia fuckeliana* Rost., Mon. App. 2.
- 1876. *Chondrioderma zeylanicum* (Berk.) Rost., Mon. App. 15.
- 1876. *Chondrioderma muelleri* Rost., Mon. App. 15.
- 1876. *Chondrioderma berkeleyanum* Rost., Mon. App. 16.
- 1888. *Didymium australe* Masee, Grev. 17 : 7.
- 1892. *Didymium pezizoideum* (Jungh.) Masee, Mon. 239.
- 1899. *Didymium parasiticum* Sacc. & Syd., Syll. Fung. 14 : 836.
- 1903. *Physarum pezizoideum* (Jungh.) Pav. & Lag., Bull. Soc. Myc. Fr. 19 : 7.

Sporangia discoidal or saucer-shaped, gregarious, stipitate, erect or nodding, grayish white, peridium thin, breaking irregularly, persistent; stipe subulate, striate, reddish brown, transparent; capillitium variable as above stated; spores pale violet-brown, spinulose or nearly smooth, about  $9\ \mu$ .

In Mycetozoa ed. 3. 71, the spores are described as  $9-17\ \mu$  in diameter. This would seem to suggest incomplete development in the sporangia with the larger spores.

Puerto Rico, British and Dutch Guiana, Bolivia; Europe, Africa, Malay Peninsula, Australia, Japan; abundant in the old-world tropics, apparently rare in the western hemisphere.

**7. *Physarella* Peck**

Bull. Torrey Bot. Cl. 9 : 61. 1882.

Sporangia cylindrical, deeply umbilicate, the upper part of the peridium inverted so as to form a thimble-shaped or bell-shaped structure; capillitium composed of slender filaments with minute fusiform nodes, together with stout spine-like processes, extending from the exterior to the interior walls of the sporangium and firmly attached to the former.

The form of the sporangium in the only species is very variable, but in typical cases is vasiform, the peridial wall at the apex introverted. The capillitium is like that of *Timadoche*, except for the presence of the "straight tubes" emphasized in the original description. These are very remarkable and at once diagnostic. They take origin in the sporangial wall and pass across to the "columella"; but at the dehiscence of the sporangium, in typical cases, they remain attached at the points of origin, projecting as stout spine-like processes. The formation of the capillitium has been studied by Bisby (1914).

*PHYSARELLA OBLONGA* (Berk. & Curt.) Morg.

Jour. Cin. Soc. Nat. Hist. 19 : 7. 1896.

Pl. X, Figs. 223, 224, 225.

- 1873. *Trichamphora oblonga* Berk. & Curt., Grev. 2 : 66.
- 1873. *Physarum rufibasis* Berk. & Br., Jour. Linn. Soc. 14 : 85.
- 1875. *Chondrioderma inflatum* Rost., Mon. 425.
- 1876. *Tilmadoche oblonga* (Berk. & Curt.) Rost., Mon. App. 13.
- 1876. *Tilmadoche hians* Rost., Mon. App. 14.
- 1882. *Physarella mirabilis* Peck, Bull. Torrey Bot. Cl. 9 : 61.
- 1888. *Tilmadoche minuta* Berl., in Sacc., Syll. Fung. 7 : 361.
- 1892. *Physarum hians* (Rost.) Massee, Mon. 296.

Sporangia scattered or gregarious, typically cup-shaped or sub-infundibuliform, stipitate, erect or cernuous, but varying through low salver-shaped cups, to irregular applanate and sessile masses; peridium thin but firm, tawny, roughened by numerous yellowish calcareous scales, at length ruptured above and often reflexed in the form of petal-like segments from which project upwards the spine-like trabecules of the capillitium; stipe when present long, terete, red, arising from a scant hypothallus and extended within the sporangium to meet the tubular pseudocolumella; capillitium of delicate violaceous threads seldom branched or united, radiating from the columella with few calcareous nodular expansions, but supported by stout, yellow, calcareous trabecules, running parallel to the capillitial threads, long adherent to the sporangial wall; spores nearly smooth, globose, violet-brown, 7-8  $\mu$ .

Not uncommon, usually in wet places. New York to South Dakota, Washington, and Louisiana, Nicaragua, British Guiana, Brazil; reported also from Ceylon, Java, Japan, Africa and the tropics generally. Rare in Europe.

Whether the form described from Portugal as *Physarella lusitanica* Torrend is a distinct species is not certain. It is small, stalked, sometimes subglobose and ovoid without pseudocolumella.

8. *Cienkowskia* Rost.

Versuch 9. 1873.

Fructification plasmodiocarpous, irregularly dehiscent, the wall a thin cartilaginous membrane destitute of lime, except for the capillitial attachments within; capillitium scanty but rigid, and characterized everywhere by peculiar hook-like branchlets, free and sharp-pointed, the spores as in *Physarum*.

The genus contains, so far, but a single species:

*CIENKOWSKIA RETICULATA* (*Alb. & Schw.*) Rost.

Versuch 9. 1873.

Pl. VII, Figs. 143, 144, 145.

1805. *Physarum reticulatum* Alb. & Schw., Consp. Fung. 90.1829. *Diderma reticulatum* (Alb. & Schw.) Fr., Syst. Myc. 3 : 112.

Plasmodiocarp an elongated, irregularly limited, close-meshed net, closely applied to the substratum, the wall thin, transversely rugulose and roughened, dull orange-yellow, splashed here and there with scarlet, sometimes entirely red, within marked by transverse calcareous ridges, supporting in part the calcareous system of the capillitium; capillitium of delicate, rigid, reticulating yellow tubules or threads with numerous free, uncinat or sickle-shaped branchlets, and large, irregular, calcareous plates, more or less transverse to the axis of the sporangium, attached to the peridial walls, as if to form septa; ordinary calcareous nodules few; spore-mass jet-black, spores by transmitted light pale violaceous, minutely roughened, 9–10  $\mu$ . Plasmodium deep brownish red.

Rare in the United States; easily recognized under the hand lens, much more by the microscopic characters quoted; probably often overlooked by the collector, as to the naked eye it presents the appearance of some imperfectly developed, dried-up plasmodium. Very unlike *Physarum serpula* Morgan, not infrequently offered by collectors as *Cienkowskia*. It is *Diderma reticulatum* of Fries, who, strangely enough, thought it might be a plasmodial phase of *Diderma vernicosum* (i. e., *Leocarpus fragilis*) (Syst. Myc. 3 : 112).

Eastern United States and Ontario to Iowa, California; Europe, Ceylon, Malay Peninsula, Java, Japan.

9. *Leocarpus* Link

Mag. Ges. Nat. Fr. Berl. 3 : 25. 1809.

Peridium double, the outer wall thick, smooth, polished, smooth inside or with deposits of lime, the inner wall delicate, hyaline; capillitium of two more or less distinct systems, the one a delicate network



of hyaline, limeless threads, the other calcareous throughout, or nearly so, the meshes large and the threads or tubules broad; columella none; pseudocolumella sometimes present.

This genus was by Link established on purely external characters. Rostafinski supplemented Link's definition by calling attention to the peculiar character of the capillitium and to the microscopic characters in general. The outer peridium is thick and strong, unlike the ordinary structure in *Physarum*. Some *physarums*, however, have a very similar outer wall; *P. brunneolum*, for instance, or *P. citrinellum*. In dehiscence and structure there is also some resemblance to some species of *Diderma*, and by Persoon and Fries the common species was so referred, but the capillitium is again definitive.

A critical study of all these things really begins with Rostafinski. Under his definition of the present genus *P. albescens* Ell. might well be entered here. Such course at present would but increase confusion, and until by future research the ontogeny of all these, and so their relationship, shall be more exactly known, the genus may be left with its historic species,—monotypic.

LEOCARPUS FRAGILIS (*Dickson*) *Rost.*

Mon. 132. 1875.

Pl. VII, Figs. 146, 147, 148.

- 1785. *Lycoperdon fragile* Dickson, Pl. Crypt. Brit. 1 : 25.
- 1795. *Diderma vernicosum* Pers., Ust. Ann. Bot. 15 : 34.
- 1797. *Trichia lutea* Trentep., Roth, Cat. Bot. 1 : 230.
- 1801. *Lycogala parasiticum* With., Br. Pl. 4 ed. 372.
- 1803. *Spumaria ramosa* Schum., Enum. Pl. Sæll. 2 : 195.
- 1803. *Physarum nitidum* Schum., Enum. Pl. Sæll. 2 : 205.
- 1803. *Physarum vernicosum* (Pers.) Schum., Enum. Pl. Sæll. 2 : 206.
- 1804. *Reticularia fragilis* (Dicks.) Poir., Lam. Encycl. 6 : 183.
- 1809. *Leocarpus vernicosus* (Pers.) Link, Mag. Ges. Nat. Fr. Berl. 3 : 25.
- 1809. *Leocarpus spermoides* Link, Mag. Ges. Nat. Fr. Berl. 3 : 25.
- 1817. *Leocarpus atrovirens* Fr., Symp. Gast. 13.
- 1827. *Leangium atrovirens* Fr., Stirp. Femsj. 83.
- 1827. *Leangium vernicosum* (Pers.) Fr., Stirp. Femsj. 83.
- 1829. *Diderma atrovirens* Fr., Syst. Myc. 3 : 103.
- 1837. *Tripotrichia elegans* Corda, Icon. Fung. 1 : 22.
- 1849. *Leocarpus ramosus* Fr., Summ. Veg. Scand. 450.
- 1921. *Liceopsis jurensis* Meylan, Bull. Soc. Vaud. Sc. Nat. 53 : 459.

Sporangia gregarious or clustered, sessile or stipitate, globose, obovoid or elongated, rusty or yellow, but occasionally deep reddish brown or nearly white, shining; peridium opening at maturity in somewhat stellate fashion; capillitium as described for the genus; stipe when



present filiform, white or yellow, weak and short; spores dark, paler at one side, coarsely warted, 12-14  $\mu$ . Plasmodium orange-yellow.

Recognizable at sight by the form and color of the sporangia. In shape and posture these resemble the eggs of certain insects, and, occurring upon dead leaves, generally where these have drifted against a rotten log, they might perchance be mistaken for such structures. With no other slime molds are they likely to be confused. The outer peridium opens irregularly, or more rarely stellately. At the center of the capillitium there is sometimes a calcareous core.

A plasmodiform gathering of this species from California, which might be mistaken for an entirely different thing, is yellow, sessile and has adherent spores; looks like a badhamia; but is, after all, a leocarpus and probably belongs here. The spores are irregularly clustered and the badhamioid section of the capillitium seems to be dominant.

Throughout the world; common.

# FAMILY DIDYMIACEÆ

Capillitium non-calcareous, simple or somewhat branched, but not forming an intricate net; peridium or stipe, or both, more or less calcareous; lime on surface of peridium often in the form of stellate crystals or crystalline disks, sometimes scanty, rarely lacking; spores violaceous black in mass.

## KEY TO THE GENERA OF THE DIDYMIACEÆ

- a. Calcareous deposits in the form of stellate crystals. . . . . b
- a. Calcareous deposits not stellate crystals. . . . . c
- b. Æthalioid. . . . . 1. *Mucilago*
- b. Plasmodiocarpous or sporangiate. . . . . 2. *Didymium*
- c. Peridium strongly and continuously calcareous. . . . . d
- c. Calcareous deposits not continuous; scattered; sometimes restricted to basal portion; rarely lacking. . . . . f
- d. Lime on surface of peridium in form of cylindrical peg-like protuberances. . . . . 3. *Physarina*
- d. Lime forming a granular or firm shell. . . . . e
- e. Peridium double; layers often distant. . . . . 4. *Diderma*
- e. Peridium single. . . . . 5. *Wilczekia*
- f. Calcareous deposits in the form of scattered, flattened scales. . . . . 6. *Lepidoderma*
- f. Calcareous deposits restricted to basal region, embedded in a dark, granular deposit. . . . . 7. *Leptoderma*

## 1. *Mucilago Micheli* ex Adans.

Fam. des Pl. 2 : 7. 1763.

1791. *Spumaria* Pers., in Gmel., Syst. Nat. 2 : 1466.

Fructification æthalioid, consisting of a large pulvinate mass composed of numerous branched and anastomosing tubes as in *Fuligo*, the

whole covered by a white, foam-like crust composed of stellate lime crystals; inner peridium delicate; capillitium of slender, limeless threads, more or less branched, terminating in the walls of the tubes and marked with occasional swellings or thickenings.

By the descriptions offered by most authors, and especially by Rostafinski's figures (Mon., pl. 9, fig. 158), a pronounced columella is called for in the structure of *Spumaria*. The individual tubes rise from a common hypothallus, and occasionally portions of this run up and give the appearance of stipitate sporangia. Sometimes also this upper extension of the hypothallus passes beyond or behind the base of such a tube or between two or more, and is more or less embraced by these in their confluent flexures. This, it seems, suggested Rostafinski's elaborate diagram; at least, no other form of columella is shown by American materials at hand.

A single species:—

*MUCILAGO SPONGIOSA* (Leyss.) Morg.

Bot. Gazette 24 : 56. 1897.

Pl. VII, Figs. 149, 150.

1783. *Mucor spongiosus* Leysser, Fl. Hal. 305.

1791. *Reticularia alba* Bull., Champ. Fr. 92.

1791. *Spumaria mucilago* Pers., in Gmel., Syst. Nat. 2 : 1466.

1805. *Spumaria alba* (Bull.) DC., Fl. Fr. 2 : 261.

1829. *Didymium spumarioides* Fr., Syst. Myc. 3 : 121, non Symb. Gast. 1818.

1833. *Diderma spumariaeforme* Wallr., Fl. Crypt. Germ. 2 : 374.

Æthelium white or cream colored, of variable size and shape, 1–7 cm. in length and half as broad, the component tubes resting upon a common hypothallus and protected by a more or less deciduous calcareous porous cortex; peridial walls thin, and where exposed, iridescent, generally whitened by a thin coating of lime crystals; capillitium scanty, of simple, mostly dark colored, slightly anastomosing threads; columella indefinite or none; hypothallus white, spongy; spore-mass black; spores violaceous, exceedingly rough, large, 12–15  $\mu$ . Plasmodium creamy white.

The plasmodium is dull white, of the consistency of cream, and is often met with in quantity on beds of decaying leaves in the woods. In fruiting, the plasmodium ascends preferably living stems of small bushes, herbaceous plants, or grasses, and forms the æthelium around the stem some distance above the ground. The cortex varies in amount, is also deciduous, so that weathered or imperfectly developed forms probably represent the form described as *Spumaria cornuta* Schum.

Two varieties of this species are recognized; one from Bolivia, var.

*dictyospora* described by R. E. Fries (Arkiv för Botanik 1 : 66) differs from the type chiefly in its finer capillitial threads and its darker spores with longer spines and fine reticulate sculpture; the other from Colorado, var. *solida* Sturgis (= *Spumaria solida* Jahn) differs, as the name implies, principally in its greater compactness and slightly smaller calcareous crystals; a desert phase.

Common in the United States, especially east of the Rockies, South America; Europe, Africa, Australia.

## 2. *Didymium* Schrad. emend. Fries

Syst. Myc. 3 : 113. 1829.

1797. *Didymium* Schrad., Nov. Gen. Plant. 20, in part.

Sporangia distinct, stipitate, sessile or even plasmodiocarpous, never æthalioid; peridium thin, irregular in dehiscence, covered with a more or less dense coating of calcareous crystals; columella more frequently present; capillitium of delicate threads, simple or sparingly branched, extending from the columella to the peridial wall.

The genus *Didymium*, as set up by Schrader, included a number of species now assigned to *Diderma*, *Lepidoderma* or *Lamproderma*. Fries set out the *didermas*; de Bary and Rostafinski completed the revision by removing the remaining alien forms.

The genus is instantly recognized by the peculiar form of its calcareous deposits, stellate crystals coating, or merely frosting, usually distinct sporangia.

### KEY TO THE SPECIES OF DIDYMIUM

- |   |                          |
|---|--------------------------|
| a. Lime crystals aggregated into discoidal, often concave scales, sessile or plasmodiocarpous. . . . .                                    | 1. <i>D. nivicolum</i>   |
| a. Lime crystals scattered or forming a powdery coating on surface of peridium. . . . .   | b                        |
| a. Crystals combined to form a shell-like crust. . . . .  | l                        |
| b. Plasmodiocarpous. . . . .  | c                        |
| b. Sporangiate. . . . .   | f                        |
| c. Yellowish or tawny; spores dark, tuberculate, 12-15 $\mu$  | 2. <i>D. fulvum</i>      |
| c. Pale brown or ochraceous; spores pale, smooth, 5-7 $\mu$   | 3. <i>D. ochroideum</i>  |
| c. Lime coat white; inner peridium usually dark. . . . .  | d                        |
| d. Flattened, thin; capillitium bearing conspicuous vesicles. . . . .   | 4. <i>D. complanatum</i> |
| d. Capillitium not bearing vesicles. . . . .  | e                        |
| e. Capillitium of vertical, tubular columns containing crystalline lime. . . . .  | 5. <i>D. anomalum</i>    |
| e. Capillitium only slightly branched; columella lacking; plasmodiocarps small; sometimes sporangiate, rarely with a short stalk. . . . . | 6. <i>D. anellus</i>     |

- e. Capillitium dense, dark; plasmodiocarp very flat; spores 11-14  $\mu$ . . . . . 7. *D. dubium*
- f. Sporangia sessile or nearly so; crust thick, fragile, distant. . . . . 8. *D. crustaceum*
- f. Typically with distinct stipes. . . . . g
- g. Peridium usually depressed or lenticular, umbilicate below. . . . . h
- g. Peridium subglobose or globose, not markedly umbilicate. . . . . k
- h. Spores irregularly reticulate; stipe often yellowish or pinkish. . . . . 9. *D. intermedium*
- h. Spores nearly smooth to spiny or warted, but not reticulate. . . . . i
- i. Stipe yellow or orange; peridium cartilaginous, yellowish; lime often in scale-like clusters. . . . . 10. *D. leoninum*
- i. Stipe pale brown; peridium grayish buff; columella yellowish, rough or spiny. . . . . 11. *D. eximium*
- i. Stipe white, fluted; fructification sometimes sessile or plasmodiocarpous. . . . . 12. *D. squamulosum*
- i. Stipe very dark to black. . . . . j
- j. Sporangia greatly flattened, discoid. . . . . 13. *D. clavus*
- j. Less compressed, large, over 0.5 mm. in diameter; capillitium dark, coarse. . . . . 14. *D. melanospermum*
- j. Smaller; capillitium pale, delicate. . . . . 15. *D. minus*
- k. Stipe dark brown to black; columella dark, often nearly obsolete. . . . . 16. *D. nigripes*
- k. Stipe yellow to yellow-brown; columella white or pallid. . . . . 17. *D. xanthopus*
- l. Sessile or short-stalked; ochraceous or yellowish white; columella very large, pulvinate. . . . . 18. *D. vaccinum*
- l. Broadly plasmodiocarpous, depressed and very thin; peridium tending to break away as a whole. . . . . 19. *D. listeri*
- l. Sessile, pulvinate to plasmodiocarpous. . . . . m
- m. Spores nearly smooth, 12-14  $\mu$ . . . . . 20. *D. difforme*
- m. Spores very dark, rough, obscurely banded and subreticulate, 12-15  $\mu$ ; peridium diderma-like, the crystals obscure. . . . . 21. *D. quitense*
- m. Spores with short spines, often clustered, sometimes with reticulate patches, 9-10  $\mu$ . . . . . 22. *D. trachysporum*

# 1. DIDYMIUM NIVICOLUM Meylan

Bull. Soc. Vaud. Sc. Nat. 57 : 40. 1929.

Pl. VIII, Fig. 177.

1925. *Didymium wilczekii* Meylan ex G. List., Mycetoza ed. 3. 120, in part.

Sporangia sessile, subglobose, 1-1.5 mm. broad, or plasmodiocarpous, white; internal layer of peridium very thin, transparent, covered with a more or less pulverulent mass of lime crystals aggregated into concave or discoid scales; capillitium of rather rigid, anastomosing pale purplish to pallid threads, bearing occasional nodules and swellings; columella



yellowish, poorly developed or obsolete; spores dark blackish purple, almost opaque, distinctly and coarsely spiny, 12–15  $\mu$ .

The scaly outer wall is distinctive. A collection submitted by M. Meylan is certainly distinct from *D. dubium* (= *D. wilczekii*).

Swiss Alps.

## 2. DIDYMIUM FULVUM *Sturgis*

Mycologia 9 : 327. 1917.

Pl. VIII, Fig. 175.

Sporangia gregarious, sessile, elongate or forming curved plasmodiocarps, sometimes confluent, rarely subglobose, concave beneath, pale raw umber in color, 0.5–0.8 mm. in width, occasionally seated on a concolorous, membranous, lime-encrusted hypothallus which may form pseudo-stalks; sporangium wall membranous, stained with yellow blotches, thickly sprinkled with clusters of large acicular crystals of pale yellowish lime; columella very much flattened or obsolete; capillitium an abundant network of delicate, almost straight or flexuose, pale purple or nearly hyaline threads, frequently with dark, calyciform thickenings as in *Mucilago*, and occasionally showing fusiform, crystalline blisters; spores dark purplish brown, coarsely tuberculate, the tubercles usually arranged in curved lines, paler and smoother on one side, 12.5–14.5  $\mu$ .

Colorado.

## 3. DIDYMIUM OCHROIDEUM *G. Lister*

Jour. Bot. 69 : 297. 1931.

Sessile, pulvinate or forming slender plasmodiocarps 0.5 mm. broad, pale brown or ochraceous, slightly grooved; wall pale orange, thickly clothed with stellate crystals, sometimes divided into small areolæ, each with a darker raised center to which a crystal adheres; hypothallus scanty, yellowish red; floor orange colored with scanty deposits of lime forming a low columella; capillitium a loose network of slender, pale purplish threads; spores pale purplish gray, nearly smooth, 5–7  $\mu$ .

Resembling *D. fulvum*, differing in the more slender plasmodiocarps, the delicate capillitium and the small, pale, nearly smooth spores.

New York; India, Japan.

## 4. DIDYMIUM COMPLANATUM (*Batsch*) *Rost., non* Fuck. 1869

Mon. 151. 1875.

Pl. VII, Figs. 151, 152, 153.

1786. *Lycoperdon complanatum* Batsch, Elench. Fung. Cont. 1 : 251.

Fructification plasmodiocarpous, creeping, flattened, thin, vein-like, annulate or reticulate, the dark colored peridium covered with white,



but not numerous, crystals; hypothallus none; columella none; capillitium of much branched, violaceous threads combined to form a rather dense net which bears numerous, peculiar, rounded vesicles, yellowish in color, 30–50  $\mu$  in diameter; spores minutely warted, 7–9  $\mu$ , pale violaceous brown. Plasmodium greenish yellow.

The defining characteristics here are the curious supplementary vesicles which are visible as brown knots under a hand lens. These are attached to and penetrated by the neighboring capillitial threads, withal warted like a spore. They suggest the curious spore-like but giant cells found in the stipes of some arcyrias. Rostafinski gives them abundant consideration, illustrating them on pl. 9, figs. 166 and 180, of the Monograph, although in the explanation of the plate he has strangely confused the species with *Didymium crustaceum* Fr. Under *Didymium serpula*, Fries may refer to the present species, although there is nothing in his description to determine the fact. The same thing may be said of the description and figures of Batsch. Rostafinski, in the Monograph, seems to have been satisfied as to the identity of Batsch's materials: in the Appendix, he writes *D. serpula*, but gives no reason.

Rare. New York, Pennsylvania (?), Iowa; Europe.

#### 5. DIDYMIUM ANOMALUM *Sturgis*

Colo. Coll. Pub. Sc. Ser. 12 : 444. 1913.

Plasmodiocarp gray, very thin, effused, 2–10 mm. long; wall single, membranous, hyaline or yellowish with rather scanty deposits of small, stellately crystalline or amorphous lime; columella none; capillitium consisting entirely of straight, membranous, tubular columns, extending from the base to the upper wall of the plasmodiocarp, 7–22  $\mu$  thick and usually containing small crystalline masses of lime; spores bright violet-brown, minutely and irregularly spinulose, 10.5–11.5  $\mu$ .

The original description gives the length of the plasmodiocarps as 2–10 cm. In our material, from Dr. Sturgis, and evidently a portion of the type collection, there are two plasmodiocarps 3–4 mm. in length, and a couple of smaller ones, less than 1 mm. Presumably "cm." was written in error. The description of the thickness, as "less than 1 mm." is misleading. They are exceedingly thin, perhaps 0.1–0.2 mm. Nevertheless the curious peg-like capillitial columns may readily be seen under a binocular.

Massee transferred Rostafinski's *Chondrioderma anomalum* to *Didymium* as *D. anomalum*. Lister thinks these names may be synonyms of *D. squamulosum*. Whatever they may represent, Sturgis' name would seem to be preoccupied, and may have to be changed. The

species is so different from other didymiums that it may have to be placed in a distinct genus. Pending further study it seems unnecessary to rename it.

Rare. Iowa, Montana, Colorado, Pennsylvania; England.

#### 6. DIDYMIUM ANELLUS *Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 148. 1894.

Pl. VIII, Figs. 156, 157, 158.

Plasmodiocarp in small rings or links, often confluent and elongated, irregularly connected, bent and flexuous, resting on a thin venulose hypothallus, or sometimes globose, the peridium dark colored, with a thin layer of stellate crystals, dehiscing in more or less circumscissile fashion; capillitium of slender, dark colored threads, which extend from base to wall, more or less branched, and combined into a loose net; columella a thin layer of brown scales; spores globose, very minutely warted, violaceous, 7–10  $\mu$ .

This minute species resembles a poorly developed, or sessile, phase of *D. melanospermum*. Some of the fructifications are spherical; such may show a very short dark stalk. The columella is usually lacking and the spores are much smaller than those of *D. melanospermum*. The original description reads "irregularly dehiscent." The tendency toward a circumscissile dehiscence, referred to in the English monograph, is apparent in specimens collected by the author of the species in Ohio in 1893.

Ohio, Iowa, Colorado, New Mexico, California; Europe, southern Asia.

#### 7. DIDYMIUM DUBIUM *Rost.*

Mon. 152. 1875.

1908. *Didymium wilczekii* Meylan, Bull. Soc. Vaud. Sc. Nat. 44 : 290.

Fructification plasmodiocarpous, white or grayish white, flat and thin, 2–16 mm. long and up to 6 mm. wide; peridium double, the outer layer composed of rather loosely compacted crystalline calcareous granules, the inner layer tough and membranous, tawny plumbeous; columella scanty or none; capillitium of rather thick brown threads vertically arranged, 270–300  $\mu$  long, sparingly united laterally and occasionally forking, especially above; spores dark violet, distinctly warted, 11–14  $\mu$ .

Mainly a mountain form. Small plasmodiocarps with firm shell-like peridium and smaller and smoother spores collected in Iowa are now referred to *D. listeri*.

Colorado; Europe.

8. *DIDYMIUM CRUSTACEUM* Fr.

Syst. Myc. 3 : 124. 1829.

Pl. VIII, Fig. 176.

1875. *Didymium confluens* (Pers.) Rost., Mon. 164.

Sporangia closely aggregated, globose, or by compression deformed, sessile, snow-white by virtue of the remarkably developed covering of calcareous crystals by which each sporangium is surrounded as if to form a crust; peridium membranous, colorless, usually shrunken above and depressed; columella pale, small, or obsolete; hypothallus scant or vanishing; capillitium of rather stout violaceous threads seldom branched except at the tips, where they are pale and often bifid, or more than once dichotomously divided; spores strongly warted, globose, violet-brown, 10–13  $\mu$ .

This species has in some ways all the outward seeming of a diderma, but cannot be referred to that genus because of the crystalline character of its crust. This is a very marked structure; loosely built up of very large crystals, it is necessarily extremely frail, nevertheless persists, arching over at a considerable distance above the peridium proper. Sometimes, however, caducous, evanescent.

The sporangia are said to be sometimes stipitate. This feature does not appear in any of the material before us. The hypothallus is sometimes noticeable under some of the sporangia where closely crowded, but is not a constant feature.

Rostafinski (Mon. 164) seems to have confused this species with Persoon's *Physarum confluens*. In the Appendix he substitutes the Friesian nomenclature. Persoon's description of his species is insufficient, and throws no light on the problem whatever.

Rare. Canada, Iowa, South Dakota, Colorado, Washington, Bolivia; Europe, Japan.

9. *DIDYMIUM INTERMEDIUM* Schroeter

Hedwigia 35 : 209. 1896.

1902. *Didymium excelsum* Jahn, Ber. Deutsch. Bot. Ges. 20 : 275.

Sporangia clustered or gregarious, discoidal and umbilicate below, or lobed or convolute, grayish white, stipitate; stipe pale yellow, tapering upwards, stuffed with lime crystals, expanding into the yellowish, discoidal, recurving columella; capillitium colorless, more or less branching; spores dark purple-brown, irregularly reticulate, 9–12  $\mu$ .

Differs from *D. squamulosum* mainly in the reticulate epispore and the structure of the stalk. A collection from southern California (O. A. Plunkett 178) determined as this species by Miss Lister, has

dull pinkish stipes and very dark spores covered with coarse, capitate spines and a coarse and irregular reticulum.

California, Brazil; Japan.

#### 10. *DIDYMIUM LEONINUM* Berk. & Br.

Jour. Linn. Soc. 14 : 83. 1873.

1876. *Lepidoderma tigrinum* (Schrad.) Rost., Mon. App. 23, in part.

1909. *Lepidodermopsis leoninus* (Berk. & Br.) Höhn., Sitzungsab. Akad. Wiss. Wien, Math.-Nat. Kl. 118 (1) : 439.

Sporangia gregarious, subglobose or flattened, stipitate, the wall cartilaginous, yellowish, covered more or less completely with white or yellowish deposits of crystalline lime; stipes short, orange or brown, containing lime, enlarged to form the globose orange columella and often connected at base by a venulose hypothallus; capillitium of slender anastomosing threads, colorless at the tips; spores violet-gray, minutely warted, 7–9  $\mu$ .

Not unlike *Lepidoderma tigrinum*, but with stellate crystals and smaller spores. The scale-like clusters in which the crystals may occur led Höhnelt to propose for this species a new genus intermediate between *Didymium* and *Lepidoderma*.

Southern Asia and Japan.

#### 11. *DIDYMIUM EXIMIUM* Peck

Rept. N. Y. State Mus. 31 : 41. 1879.

1892. *Didymium fulvellum* Masee, Mon. 237.

1925. *Didymium nigripes* Fr. var. *eximium* (Peck) Lister, Mycetozoa ed. 3. 116.

Sporangia scattered, dull grayish yellow or gray, depressed-globose, umbilicate, minute, stipitate; peridium comparatively thick, tenacious, especially persistent below, tawny or yellow; stipe pale brown or orange, erect, even or slightly enlarged at base; hypothallus scant or none; columella prominent, more or less discoidal, rough or spinulose, especially on the upper surface, yellow or pallid; capillitium not abundant, pale fuliginous, often branching and anastomosing to form a loose net; spores nearly smooth, dark violaceous by transmitted light, 8.5–9.5  $\mu$ .

The species differs from *D. xanthopus* in several particulars—in the much firmer, more persistent and less calcareous peridium with a distinct yellowish cast, in the more complex capillitium, in the darker and larger spores and especially in the peculiar and prominent columella, which is not only rough, but even “sometimes spinulose even to the extent of long spicules penetrating to one-third the height of the sporangia.”



As stated under *D. nigripes*, this species and *D. xanthopus* are called varieties only of *nigripes*. They are so retained in Mycetozoa, 3rd edition. Since, however, they are the usual presentation of the species in the United States, it seems wise to let them stand for the present, as here. They are quite distinguishable; *D. eximium* especially well marked.

Apparently rare, it yet ranges from New York to Iowa, in rather large colonies. Also Europe, Ceylon, Java.

## 12. DIDYMIUM SQUAMULOSUM (Alb. & Schw.) Fr.

Symb. Gast. 19. 1818.

Pl. VIII, Figs. 159, 160, 161, 162, 163.

- 1805. *Diderma squamulosum* Alb. & Schw., Consp. Fung. 88.
- 1815. *Licea stipitata* DC., Fl. Fr. ed. 2. 101.
- 1815. *Didymium effusum* Link, Mag. Ges. Nat. Fr. Berl. 7 : 42.
- 1817. *Trichia pedicellata* Poirét, Lam. Encycl. 13 : 373.
- 1827. *Cionium squamulosum* (Alb. & Schw.) Spreng., Syst. Veg. 4 : 529.
- 1829. *Didymium costatum* Fr., Syst. Myc. 118.
- 1829. *Didymium herbarum* Fr., Syst. Myc. 120.
- 1830. *Physarum liceoides* Duby, in DeCandolle, Bot. Gall. ed. 2. 2 : 461.
- 1869. *Didymium radiatum* Berk. & Curt., Jour. Linn. Soc. 10 : 348.
- 1873. *Didymium neglectum* Berk. & Br., Jour. Linn. Soc. 14 : 83.
- 1873. *Didymium fuckelianum* Rost., in Fuckel, Symb. Myc., Nachtr., 73.
- 1875. *Didymium macrospermum* Rost., Mon. 161.
- 1875. *Didymium discoideum* Rost., Mon. 162.
- 1876. *Chondrioderma cookei* Rost., Mon. App. 17.
- 1876. *Physarum tussilaginis* Berk. & Br., Ann. Mag. Nat. Hist. 4 ser. 17 : 139.
- 1879. *Didymium angulatum* Peck, Rept. N. Y. State Mus. 31 : 41.
- 1888. *Didymium cookei* (Rost.) Raunk., Bot. Tidssk. 17 : 86.
- 1888. *Didymium affine* Raunk., Bot. Tidssk. 17 : 88.
- 1891. *Didymium bonianum* Pat., Jour. de Bot. 5 : 316.
- 1892. *Didymium tussilaginis* (Berk. & Br.) Massee, Mon. 244.

Sporangia in typical forms gregarious, globose or depressed-globose, usually stipitate, 0.5–1 mm. in diameter, but ranging through completely sessile and more or less fused sporangia to plasmodiocarps; peridium a thin iridescent membrane covered more or less richly with minute crystals of lime; the stipe, when present, snow-white or rarely yellowish to orange, fluted or channelled, stout, even; columella white, conspicuous; hypothallus usually small or obsolete; capillitium of delicate branching threads, usually colorless or pallid, sometimes with conspicuous calyciform thickenings; spores violaceous, minutely warted or spinulose, often with clusters of coarser and darker spines, 8–11  $\mu$ . Plasmodium yellow.

This, one of the most beautiful species in the whole series, is re-



markable for the variations which it presents in the fruiting phase. The hypothallus, sometimes entirely wanting, is anon well developed, even continuous, venulose, from stipe to stipe. The capillitium varies much in abundance as in color; when scanty, it is colorless and in every way more delicate, when abundant, darker in color and sometimes with conspicuous thickenings.

*D. fuckelianum* Rost., as shown in N. A. F. 2090, and in some private collections, seems to be a rather stout phase of this species; the stipe is more abundantly and deeply plicate, is sometimes tinged with brown, and the capillitium is darker colored and coarser than in what is here regarded as the type of the species; but withal the specimens certainly fail to meet the requirements of Rostafinski's elaborate description and figure (Mon. 161, fig. 134).

*D. effusum* Link probably stands for a sessile form of this species, but Link's brief description is antedated by the much better one of Albertini and Schweinitz.

Nicaragua specimens not only show a continuous vein-like hypothallus, but have the peridia often confluent, the columellæ in such cases confluent, the stipes distinct. Furthermore, the largest spores reach the limit of  $12.5\ \mu$ , and perhaps the larger number range from  $10$ – $12.5\ \mu$ , and all are very rough. This corresponds with *D. macrospermum* Rost., which is distinguished, says the author (Mon., p. 162), "chiefly by the large and strongly spinulose spores." However, the same sporangia in our Central American specimens yield spores  $9.5$ – $12.5\ \mu$ , a remarkable range, so that *D. macrospermum*, on this side of the ocean, at least, cannot be distinguished from *D. squamulosum*, so far as spores are concerned. A similar remark may be made relative to the form of the columella which Rostafinski, in his figures especially, would make diagnostic. The columella in the sporangium with largest and roughest spores is that of a perfectly normal *D. squamulosum*.

Cosmopolitan. Generally distributed throughout the wooded regions of North America, from New England to Nicaragua, and from Canada to California, West Indies, Bolivia, Brazil, Argentina. Not uncommon about stable-manure heaps, in flower beds, and on richly manured lands.

Var. *claviforme* Sturgis, Colo. Coll. Pub. Sc. 12 : 27, 1907 (= *D. annulatum* Macbr., N. A. Slime-Moulds ed. 2. 125. 1922) is a small delicate phase,  $0.4$ – $0.6$  mm. in diameter, with a deeply umbilicate or annulate sporangium and a reduced columella. The spores are slightly smaller than in the typical form,  $8$ – $10\ \mu$ , and the clustered spines more noticeable. While at times it seems quite distinct, it is perhaps too

close to certain small developments of the typical form to warrant specific recognition.

Colorado, Oregon, Washington; Germany.

13. *DIDYMIUM CLAVUS* (Alb. & Schw.) Rabenhorst

Deutsch. Krypt. Fl. 1 : 280. 1844.

Pl. VII, Figs. 154, 155.

1805. *Physarum clavus* Alb. & Schw., Consp. Fung. 96.

1829. *Didymium melanopus* Fr., Syst. Myc. 3 : 114.

1873. *Didymium commutabile* Berk. & Br., Jour. Linn. Soc. 14 : 83.

1892. *Didymium radiatum* Berk. & Curt. ex Massee, Mon. 229, in part.

1892. *Didymium neglectum* Massee, non Berk. & Br., Mon. 231.

1899. *Didymium masseeanum* Sacc. & Syd., Syll. Fung. 14 : 836.

Sporangia gregarious, pale gray, discoid or pileate, depressed, stipitate; peridium dark colored, frosted with calcareous crystals above, naked below; stipe short, slender, tapering upward, furrowed, black, arising from a more or less distinct hypothallus; columella obsolete; capillitium of delicate threads, pale or colorless, little branched; spores violaceous, pale, nearly smooth, 6–8  $\mu$ . Plasmodium gray.

This species is well differentiated, easy of recognition by reason of its peculiar discoid sporangium, calcareous above, naked and black beneath. *D. neglectum* Massee, reported from Philadelphia, is said to be a slender form of the present species. The figures of Albertini and Schweinitz are excellent, as is their description.

Occasionally collections occur in which the spores are distinctly warted, with clusters of darker warts scattered over the surface. These seem otherwise to be typical. Höhnelt (1909) believes that *D. commutabile* is a related but distinct species, characterized by a long, white or yellowish and strongly encrusted stipe and by smaller spores, 5–6  $\mu$  in diameter.

Pennsylvania, Wisconsin, Ohio, Iowa, Washington, Bolivia, Brazil, Argentina; Europe, Africa, East Indies, Japan and the tropics generally. Not common in the United States.

14. *DIDYMIUM MELANOSPERMUM* (Pers.) Macbr.

N. A. Slime-Moulds 88. 1899.

Pl. VIII, Figs. 164, 165.

1794. *Physarum melanospermum* Pers., Roem. N. Mag. Bot. 1 : 88.

1797. *Didymium farinaceum* Schrad., Nov. Gen. Pl. 22.

1797. *Trichia compressa* Trentep., Roth, Cat. Bot. 1 : 229.

1797. *Trichia depressa* Trentep., Roth, Cat. Bot. 1 : 231.

1799. *Trichia sphaerocephala* Sow., Engl. Fung. 240.

1801. *Physarum farinaceum* (Schrad.) Pers., Syn. Meth. Fung. 174.

1808. *Trichia farinosa* Poiret, in Lam. Encycl. 8 : 53.  
 1809. *Physarum sinuosum* Lk., Mag. Ges. Nat. Fr. Berl. 3 : 27.  
 1809. *Physarum capitatum* Lk., Mag. Ges. Nat. Fr. Berl. 3 : 27.  
 1817. *Strongylium minus* Fr., Symb. Gast. 9.  
 1818. *Didymium physaroides* Fr., Symb. Gast. 21.  
 1827. *Cionium lobatum* Spreng., Syst. Veg. 4 : 529.  
 1833. *Cionium farinaceum* (Schrad.) Link, Handb. 3 : 410.  
 1889. *Didymium fairmani* Sacc., Jour. Myc. 5 : 78.

Sporangia gregarious, hemispheric, depressed, 0.6–1 mm. in diameter, umbilicate below, stipitate or sessile; peridium firm, dull brown in color, frosted with minute crystals of lime, breaking irregularly; stipe, when present, short, stout, dull black, opaque, fluted, arising from a broad base or hypothallus; columella large, prominent, dark colored, rough above, concave below; capillitium of more or less sinuous, usually dark colored threads, sparingly branched, and often with calyciform thickenings; spore-mass black, spores by transmitted light purple, spinulose or rough, 11–14  $\mu$ .

A well-marked and common species, distinguished by its depressed sporangium and dark colored, opaque stipe. The latter is usually very short, almost completely concealed in the concavity of the umbilicate sporangium. The columella is dark colored, forming the floor of the peridial cavity.

New England to Washington and Alabama, West Indies, Bolivia, Brazil; Europe, Africa, Java.

### 15. DIDYMIUM MINUS *Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 145. 1894.  
 Pl. VIII, Figs. 166, 167.

1892. *Didymium farinaceum* Schrad. var. *minus* Lister, Mycetozoa 97.  
 1925. *Didymium melanospermum* Macbr. var. *minus* Lister, Mycetozoa ed. 3. 115.

Sporangia gregarious, depressed-globose, umbilicate below, whitish or gray, small, about 0.5 mm. in diameter, stipitate; stipe erect, rather slender, black, faintly striate, usually equalling the diameter of the sporangium in length, sometimes shorter, rarely lacking; columella distinct, dark brown, globose or depressed-globose, attaining about the center of the sporangium, rough; capillitium delicate, almost colorless, radiating, sparsely branched; spores in mass black, by transmitted light violet, minutely warted, 8–11  $\mu$ .

Distinguished from *D. melanospermum* by the smaller size, the less flattened sporangium, the smoother and usually less limy peridium, the longer stem and the smaller, paler, less strongly warted spores; from

*D. nigripes* by the shorter, thicker stem and the somewhat flattened and more distinctly umbilicate sporangium.

New England to Alabama and Nebraska, Washington; Europe, Africa, Java, Japan, probably cosmopolitan.

16. *DIDYMIUM NIGRIPES* (Link) Fr.

Syst. Myc. 3 : 119. 1829.

Pl. VIII, Figs. 168, 169.

1809. *Physarum nigripes* Link, Mag. Ges. Nat. Fr. Berl. 3 : 27.

1818. *Physarum microcarpon* Fr., Symb. Gast. 23.

1846. *Didymium porphyropus* Dur. & Mont., Fl. Alg. 409.

1875. *Didymium microcarpon* (Fr.) Rost., Mon. 157.

1888. *Didymium tenue* Pat., Bull. Soc. Myc. Fr. 4 : 96.

Sporangia gregarious, globose or hemispherical, 0.3–0.5 mm. in diameter, umbilicate beneath, white, stipitate; peridium smoky, covered with minute calcareous crystals; columella dark; stipe slender, erect, black, opaque; hypothallus scutate, black; columella distinct, globose, black or dark brown; capillitium of delicate threads, pale brown or colorless, with occasional brown thickenings or nodes, sparingly branched; spores pale, violaceous by transmitted light, minutely warted, 7–10  $\mu$ .

Rostafinski adopted Fries' name *microcarpon* simply because he thought it more appropriate. Fries describes the columella "none or . . . black." It is doubtful whether we have the typical Friesian form on this continent. The fructification is in our specimens small, about 0.4 mm., and the spores, as noted by Morgan, small; otherwise the species is very close to *D. xanthopus*. Lister regards both *D. xanthopus* and *D. eximium* as merely varieties of *nigripes*.

New York, Ohio, Wisconsin, Iowa, Washington, Puerto Rico, British Guiana, Bolivia, Argentina. Cosmopolitan.

17. *DIDYMIUM XANTHOPUS* (Ditmar) Fr.

Syst. Myc. 3 : 120. 1829.

Pl. VIII, Figs. 170, 171.

1817. *Cionium iridis* Ditmar, in Sturm, Deutsch. Fl. 3 : 13.

1817. *Cionium xanthopus* Ditmar, in Sturm, Deutsch. Fl. 3 : 37.

1829. *Didymium iridis* Fr., Syst. Myc. 3 : 120.

1829. *Didymium pertusum* Berk., in Sm. Eng. Fl. 5 (2) : 313.

1873. *Didymium proximum* Berk. & Curt., Grev. 2 : 52.

1892. *Didymium microcarpon* (Fr.) Rost. ex Macbride, Nat. Hist. Bull. Iowa 2 : 146, in part.

1892. *Didymium elegantissimum* Massee, Mon. 243.

1925. *Didymium nigripes* Fr. var. *xanthopus* (Ditmar) Lister, Mycetozoa ed. 3. 116.



Sporangia gregarious, white, globose, slightly umbilicate, stipitate; peridium thin, and nearly or quite colorless, frosted with crystals of lime; stipe yellowish or yellowish brown, corneous, erect, subulate, slender; hypothallus none; columella pale or white, turbinate, globose or depressed-globose; capillitium of dull brown or colorless threads more or less branched, always white at the tips; spores violaceous, nearly smooth, 7-9  $\mu$ .

This seems to be the most common form in the United States. It is distinguished from the preceding by the longer, more delicate, generally orange-yellow stem with pale or white columella. N. A. F. 412 and 2089 are examples of *D. xanthopus*. The columella in blown-out specimens is very striking, well confirming the diagnosis of Fries, "valde prominens, globosa, stipitata, alba." Berkeley makes the color of the capillitium diagnostic of *D. proximum*, but this feature is insufficient.

As noted in the synonymy, in the Lister monograph this is regarded as merely a variety of *D. nigripes*. This view is confirmed to some extent by the studies of Miss Cayley (1929) who grew both forms in artificial culture and found that the color of the stalks was inconstant, varying with the amount of coloring matter in the substratum. She states, however, that the columella in the *xanthopus* cultures was always white, and suggests that some of the confusion is due to the occurrence of hybridization between the two forms, and possibly between them and *D. eximium*. Skupienski (1930) grew *D. nigripes* in pure culture and found that when the plasmodium fruited at 8-10° C. typical sporangia were produced, while when the same plasmodium fruited at 18-20° C. the sporangia resembled those of *D. xanthopus*, although both spores and capillitium were abnormal. Intermediate forms undoubtedly occur, but as a rule the collections as brought in from the field are easily distinguishable. The species may be recognized tentatively pending fuller information.

*Cionium iridis* Ditm., cited by Fries, apparently appeared before *C. xanthopus*. If the synonymy should be confirmed, and the species continue to be recognized, the name *iridis* takes precedence.

Common in the eastern United States and the Mississippi valley, also Washington, Nicaragua, Bolivia, Argentina; Europe, Africa, Ceylon, Java, Japan. Generally distributed in temperate regions.

#### 18. DIDYMIUM VACCINUM (Dur. & Mont.) Buchet

Bull. Soc. Myc. Fr. 36 : 110. 1920.

1846. *Diderma vaccinum* Dur. & Mont., Expl. Sc. Alg. 407.

1875. *Chondrioderma vaccinum* (Dur. & Mont.) Rost., Mon. 180.

1898. *Didymium trochus* List., Jour. Bot. 36 : 164.



Sporangia plasmodiocarpous, hemispherical or turbinate, sessile or very short-stalked, cream colored or white; peridium double, the outer shell-like, the inner membranaceous, more or less adherent to the outer, both caducous together, leaving the thickened base surrounding an expanded columella; stipe, when present, very short, stout; capillitium colorless, nearly simple; spores brownish purple, strongly warted, 9–10  $\mu$ .

On straw, decaying leaves, especially succulents such as Agave, and on decaying cactus stems.

Said to be common in England, occurring also in Portugal, Algeria, Japan. The only American collection thus far seems to be one made by Bethel, at Monrovia, California, on the usual substrata.

#### 19. DIDYMIUM LISTERI *Massee*

Mon. 244. 1892.

1894. *Didymium dubium* Rost. ex Lister, Mycetozoa 95, in part.

Plasmodiocarp pulvinate-compressed, thin, occurring in irregular scattered patches 3–7 mm. in extent; outer wall white, shell-like, covered with a powdery layer of stellate crystals, the inner peridium delicate, membranous, dark, adherent, the whole tending to break away entire, leaving the mass of spores and capillitium exposed; columella none; capillitium dense, threads parallel, rarely over 200  $\mu$  long, branching acutely and dichotomously and connected by transverse bars, dark brown, the tips paler; spores globose, dingy lilac, minutely warted, 8–11  $\mu$ .

Formerly confused with *D. dubium* Rost., which, however, has much larger spores and a different peridium. See that species, also Journal of Botany 64 : 226, 1926.

Iowa, Bermuda; Great Britain, Germany.

#### 20. DIDYMIUM DIFFORME (*Pers.*) *Duby*

Bot. Gall. 2 : 858. 1830.

Pl. VIII, Figs. 172, 173.

1797. *Diderma difforme* Pers., Tent. Disp. Meth. 19.

1803. *Licea cæsia* Schum., Enum. Pl. Sæll. 2 : 219.

1809. *Physarum difforme* Lk., Mag. Ges. Nat. Fr. Berl. 3 : 27.

1813. *Amphisporium versicolor* Link, Mag. Ges. Nat. Fr. Berl. 7 : 41.

1817. *Didymium cyanescens* Fr., Symb. Gast. 19.

1823. *Licea alba* Nees, in Kunze & Schmidt Myc. 2 : 66.

1823. *Lycogala minutum* Grev., Scot. Crypt. Fl. 40.

1825. *Reticularia pusilla* Fr., Syst. Orb. Veg. 1 : 147.

1829. *Diderma cyanescens* Fr., Syst. Myc. 3 : 109.

1829. *Physarum album* Fr., Syst. Myc. 3 : 147.

1829. *Physarum caesium* Fr., Syst. Myc. 3 : 147.  
 1832. *Licea macrospora* Schw., Trans. Am. Phil. Soc. II. 4 : 258.  
 1836. *Diderma nitens* Klotzsch, in Sm., Engl. Fl. 5 (2) : 311.  
 1837. *Diderma neesii* Corda, Icon. 2 : 23.  
 1849. *Leocarpus cyanescens* Fr., Summ. Veg. Scand. 450.  
 1850. *Diderma libertianum* Fres., Beitr. Myc. 28.  
 1864. *Didymium libertianum* (Fres.) de Bary, Mycetozen 124.  
 1873. *Chondrioderma difforme* (Pers.) Rost. in Fuckel, Symb. Myc. Nachtr. 73.  
 1876. *Chondrioderma liceoides* Rost., Mon. App. 17.  
 1899. *Diderma persoonii* Macbr., N. A. Slime-Moulds 96.  
 1919. *Didymium tubulatum* Jahn, Ber. Deutsch. Bot. Ges. 36 : 663.

Plasmodiocarpous, the smooth, white outer peridium separable from the thin, colorless or purplish inner layer; capillitium of rather coarse, flat, dichotomously branching threads, broader below; spores minutely warted or almost smooth, dark brown, 12–14  $\mu$ .

The white crust-like outer wall has more than once carried this species into *Diderma*. It is doubtful whether or not *Chondrioderma calcareum* Rost. should be referred here. Miss Lister cites a variety, *comatum*, with finer and more abundant capillitium, which may represent Rostafinski's species. The spores seem to be paler and somewhat smaller. In some of our specimens the crust-like outer peridium shows crystals on the broken edge only. The var. *repandum* G. Lister (*D. tubulatum* Jahn) is characterized by tubular or funnel-shaped ingrowths reaching from the upper part of the peridium to the base. It may prove to be distinct.

Reported common on Long Island by Mr. Hagelstein and in Oregon by Mr. H. C. Gilbert, rare elsewhere in the United States, also reported from Bolivia; not uncommon in the old world.

## 21. DIDYMIUM QUITENSE (*Pat.*) *Torr.*

Fl. Myx. 150. 1909.

Pl. VIII, Fig. 174.

1895. *Chondrioderma quitense* Pat., Bull. Soc. Myc. Fr. 11 : 212.

Sporangia more or less plasmodiocarpous, scattered, depressed, white; the outer peridium distinct, crust-like, remote from the thin membranous inner wall; columella undefined; capillitium brown, much branched, forming a network, especially outwardly; spores very dark violaceous brown, rough with a tendency to obscure reticulation, 12–15  $\mu$  or larger, up to 17  $\mu$ .

This species is different from *D. difforme* chiefly in the rougher and somewhat banded episore. The collection with large spores, 15–17  $\mu$ , is somewhat doubtfully here referred.

Colorado, Montana, California, Ecuador.

22. *DIDYMIUM TRACHYSPORUM* G. Lister

Essex Naturalist 20 : 113. 1922.

Sporangia more or less scattered, white or cream white, either hemispherical, 0.2–0.6 mm. in diameter, or forming slender, curved, simple or ring-shaped plasmodiocarps; the outer wall a smooth or wrinkled crust of closely compacted lime granules; the inner wall membranous, colorless; the floor of sporangium pale yellow, membranous, with a thickened margin, with scanty, rarely abundant deposits of lime crystals; capillitium rather scanty, variable, consisting usually of a network of colorless or purplish, stout or slender threads, sometimes with vesicular expansions enclosing lime crystals; spores brownish purple, marked with short spines which are scattered or grouped in clusters, rarely with patches of broken reticulation, the spore wall often traversed by a low ridge, 9–10  $\mu$ . Plasmodium colorless.

Oregon; Europe.

3. *Physarina* von Höhnelt

Sitzungsb. K. Akad. Wiss. Wien, Math.-Nat. Kl. 118 (1) : 431. 1909.

Sporangia rough with numerous blunt, cylindrical, peg-like processes projecting from the surface; capillitium without nodes.

One species.

## PHYSARINA ECHINOCEPHALA von Höhnelt

Sitzungsb. K. Akad. Wiss. Wien, Math.-Nat. Kl. 118 (1) : 432. 1909.

Pl. XXI, Fig. 573.

Sporangia gregarious, stalked, subglobose, 0.4–0.5 mm. in diameter, pale pink or flesh colored in herbarium, blackish brown when gathered; outer layer of sporangium somewhat cartilaginous, bearing numerous cylindrical processes filled with lime; inner wall smooth, membranous; stalk stout, tapering, furrowed, flesh colored to nearly white, filled with lime, continued above into a pale subglobose columella; capillitium violet-brown, paler and branching at tips; spores nearly smooth, brownish violet, 7–9  $\mu$ .

Java.

4. *Diderma* Persoon

Roem. N. Mag. Bot. 1 : 89. 1794.

1873. *Chondrioderma* Rost., Versuch 13.

Sporangia plasmodiocarpous or distinct, sessile or stipitate; peridium as a rule double, the outer wall generally calcareous with the lime granules globular, non-crystalline, the inner wall very delicate and often,

in the mature fructification, remote from the outer; columella generally prominent.

The genus *Diderma* is usually easy of recognition, by reason of its double wall, the outer crustaceous and usually calcareous, and its limits remain substantially as originally set by Persoon. His definition is as follows:

“*Peridium ut plurimum duplex; exterius fragile; interius pellucens, subdistans. Columella magna, subrotunda. Fila parca latentia.*” (Syn. Meth. Fung. 164.)

Rostafinski changed the name of the genus to *Chondrioderma*, seemingly at de Bary's suggestion, and seems to have regarded Persoon's definition as applicable to those species in which the wall is not only plainly double, but in which the two walls are as plainly remote from each other. More especially he esteemed a new generic name necessary, since he regarded several included species, e. g., *D. spumarioides*, *D. hemisphericum*, as monodermic. Persoon's *Diderma*, when established, included *D. floriforme*. He caused some confusion in his later work by admitting certain physarums. This induced Schrader to throw all the didermas into his new genus, *Didymium*.

#### KEY TO THE SPECIES OF DIDERMA

- |   |                      |
|---|----------------------|
| Outer wall of sporangium calcareous, crustose, fragile;<br>inner wall membranous, usually distant, rarely lacking | I. Section EUIDERMA  |
| Outer wall of sporangium cartilaginous; inner wall often<br>not distinct, or concrete with the outer              | II. Section LEANGIUM |

#### I. EUIDERMA

- |  |                               |
|--|-------------------------------|
| a. More or less plasmodiocarpous or on a plasmodiocarp-like hypothallus  | b                             |
| a. Sporangiate or forming small separate plasmodiocarps  | d                             |
| b. Broadly effused, flattened, varying to short plasmodiocarps massed in a larger network; occasionally of separate sporangia; spores 7–10 $\mu$ | 1. <i>D. effusum</i>          |
| b. Plasmodiocarps smaller, spores larger   | c                             |
| c. Plasmodiocarpous, or sporangiate on a plasmodiocarp-like hypothallus; spores about 12 $\mu$   | 2. <i>D. alpinum</i>          |
| c. Plasmodiocarpous to discoid, rarely with a short stalk; spores 10–15 $\mu$  | 3. <i>D. chondrioderma</i>    |
| d. Spores marked with prominent but incomplete reticulations   | 4. <i>D. subdictyospermum</i> |
| d. Spores warted, spiny or nearly smooth   | e                             |
| e. Brown or brick-red, fading to brownish ochraceous   | 5. <i>D. simplex</i>          |
| e. White, grayish or pale flesh colored  | f                             |
| f. Seated on a common hypothallus  | g                             |
| f. Sporangia not on a common hypothallus   | i                             |
| g. Outer wall not porcelain-like, adhering to inner wall   | 6. <i>D. spumarioides</i>     |

- g. Outer wall firm, porcelain-like, separate from the inner wall. . . . . *h*  
*h.* Sporangia in a dense, crustose mass; walls remote; spores 11–14  $\mu$ . . . . . 7. *D. crustaceum*  
*h.* Sporangia gregarious; walls remote; spores 7.5–10  $\mu$  . . . . . 8. *D. globosum*  
*h.* Sporangia crowded, large, substipitate, walls close; inner wall and columella brownish or flesh colored . . . . . 9. *D. lyallii*  
*i.* Sporangia sessile. . . . . *j*  
*i.* Sporangia stipitate. . . . . *k*  
*j.* Outer peridium white or pallid; inner distinct, ochraceous; capillitium duplex. . . . . 10. *D. niveum*  
*j.* Outer wall porcelain-like, pale rose; capillitium simple. . . . . 11. *D. testaceum*  
*k.* Sporangia greatly flattened, discoid. . . . . 12. *D. hemisphaericum*  
*k.* Sporangia hemispherical to subglobose. . . . . 13. *D. montanum*

## II. LEANGIUM

- a.* Sessile, rarely short-stipitate. . . . . *b*  
*a.* Usually with a distinct stipe. . . . . *f*  
*b.* Inner peridium distinct. . . . . *c*  
*b.* Peridial layers more or less united. . . . . *d*  
*c.* Brownish or pinkish gray; spores 12–13  $\mu$ . . . . . 14. *D. sauteri*  
*c.* Ochraceous or olivaceous; spores 9–11  $\mu$ . . . . . 15. *D. ochraceum*  
*c.* White above, deep red below; columella clavate, rough, deep red. . . . . 16. *D. cor-rubrum*  
*d.* Middle layer of peridium subcrystalline; columella usually lacking. . . . . 17. *D. trevelyani*  
*d.* Middle layer of peridium not crystalline. . . . . *e*  
*e.* Peridium chocolate, marked before dehiscence with lines converging at apex; columella white. . . . . 18. *D. asteroides*  
*e.* Pinkish or red-brown; columella cream colored, rough . . . . . 19. *D. antarcticum*  
*e.* Dark gray to nearly black; columella lacking. . . . . 20. *D. imperiale*  
*f.* Stipe short, less than height of sporangium. . . . . *g*  
*f.* Stipe equal to or exceeding height of sporangium. . . . . *h*  
*g.* Ashy to brownish drab. . . . . 21. *D. radiatum*  
*g.* Umber to red-brown. . . . . 22. *D. roanense*  
*g.* Orange-red or vermilion. . . . . 23. *D. lucidum*  
*h.* Brownish gray, ochraceous brown or umber; wall smooth; dehiscence revolute. . . . . 24. *D. floriforme*  
*h.* White or grayish; wall rugulose, areolate and areolately dehiscent. . . . . 25. *D. rugosum*

## 1. DIDERMA EFFUSUM (Schw.) Morgan

Jour. Cin. Soc. Nat. Hist. 16 : 155. 1894.

Pl. VIII, Figs. 178, 179, 180, 181.

1832. *Physarum effusum* Schw., Trans. Am. Phil. Soc. II. 4 : 257.

1898. *Physarum crustiforme* Speg., An. Mus. Nac. Buenos Aires 6 : 200.

Fructification composed of flattened white sporangia massed in plasmodiocarpous fashion, appanate, reticulate, or often forming a



broadly effused mass; outer peridium a thin, white, calcareous crust closely applied to the delicate membranous and colorless inner wall; columella thin, alutaceous, scarcely more than a base of the plasmodiocarp; capillitium pale, consisting of short threads somewhat branched toward their distal extremities; spores faintly echinulate, with a few clusters of darker and larger, but still minute spines, 7–9  $\mu$ .

The two layers of the peridium are sometimes scarcely distinguishable, the outer a thin, crustose shell closely applied to the membranous inner wall.

New York, Ohio, Nebraska, Argentina; apparently rare in America. Widespread in the old world and said to be not infrequent in the British Isles. Africa, East Indies, Japan.

Var. *reticulatum* (Rost.) Macbride, N. A. Slime-Moulds ed. 2. 131, 1922 (= *Didymium reticulatum* Rost., in Fuckel, Symb. Myc. Nachtr. 73, 1873; *Chondrioderma reticulatum* Rost., Mon. 170, 1875; *Diderma reticulatum* (Rost.) Morg., Jour. Cin. Soc. Nat. Hist. 16 : 155, 1894). Sporangia gregarious, generally rounded, not much depressed, flat, sometimes, especially toward the margin of a colony, elongate, venulose or somewhat plasmodiocarpous, dull white, the inner peridium ashen or bluish, remote from the calcareous crust, which is extremely fragile, easily shelling off; columella indistinguishable from the base of the sporangium, thin, alutaceous; capillitium of short, generally colorless, delicate, sparingly branching or anastomosing threads perpendicular to the columella; spores black in mass, by transmitted light violet-tinted, nearly smooth, with a few shadows marking clusters of minute spines, 7–9  $\mu$ .

Perhaps our most common form. Found in fall on dead twigs, leaves, etc. Recognized by its rather large, white, depressed or flattened sporangia tending to form reticulations, and hence suggesting the name. The lines of fruiting tend to follow the venation of the supporting leaf; where the sporangium is round, the columella is a distinct rounded or cake-like body; where the fruit is venulose, the columella is less distinct.

New York, Pennsylvania, Ohio, Wisconsin, Iowa, Nebraska, probably throughout the eastern United States, Brazil; Europe, Ceylon, Java.

## 2. DIDERMA ALPINUM Meylan

Bull. Soc. Vaud. Sc. Nat. 51 : 261. 1917.

1913. *Diderma globosum* Pers. var. *alpinum* Meylan. Ann. Cons. Bot. Genève 310.

Plasmodiocarpous or sporangiate, the plasmodiocarps short, the sporangia sessile and crowded on a plasmodiocarp-like hypothallus,

0.7–1 mm. broad; outer layer smooth, shell-like, inner membranous, gray or somewhat iridescent; columella convex, rough, ochraceous to flesh colored; capillitium rather stout, of straight to flexuose, branching threads, pale to purplish, with numerous dark, fusiform thickenings; spores dark purple, rather roughly warted, 11.5–12.3  $\mu$ .

Miss Lister says the inner wall is flesh colored. This is not the case in our specimens, received from M. Meylan. The spores also average 12.3  $\mu$ , somewhat larger than as described.

Switzerland, abundant in the mountains, Hungary.

### 3. DIDERMA CHONDRIODERMA (*de B. & Rost.*) *G. List.*

Mycetozoa ed. 3. 258. 1925.

Pl. XXI, Figs. 566, 567, 568, 569.

1872. *Didymium chondrioderma* de B. & Rost., in Alex. Stroj. 89.

1875. *Chondrioderma alexandrowiczii* Rost., Mon. 169.

1913. *Diderma arboreum* G. List. & Petch, Jour. Bot. 51 : 2. 1913.

Sporangia scattered, discoid, sessile or rarely stalked, 0.5–0.7 mm. in diameter, or forming expanded and lobed, flattened plasmodiocarps 1–3 mm. in diameter, white or purplish gray from lack of lime; sporangium wall membranous with deposits of round or angular lime granules either united to form a thin crust or sparsely distributed, often with scattered deposits of refuse matter; stalk, when present, very short, dark brown; columella flesh colored, sometimes nearly obsolete; capillitium rather coarse, purplish or colorless, often with membranous expansions at the joints; spores very minutely and closely spinulose, pale purplish gray, 10–15  $\mu$ . Plasmodium white, then violet.

Distinguished from *D. effusum* by the larger spores and coarser capillitium.

Iowa; Europe, Ceylon, Malay Peninsula, Japan.

### 4. DIDERMA SUBDICTYOSPERMUM (*Rost.*) *Lister*

Mycetozoa ed. 2. 101. 1911.

1876. *Chondrioderma subdictyospermum* Rost., Mon. App. 16.

1892. *Chondrioderma dealbatum* Mass., Mon. 207.

Sporangia crowded, sessile on a white hypothallus, subglobose or hemispherical, 0.3–0.5 mm. in diameter, white; outer sporangium wall thick, fragile, crustose, closely adhering to the membranous inner layer; columella hemispherical or subglobose, white; capillitium dark purplish, rigid, sparingly branched; spores purplish brown, marked with prominent raised ridges or broken reticulations, about 12  $\mu$ .

The type in the British Museum is labelled *Didymium dealbatum*

Berk. & Curt., and the species was distributed under that name in Fendler, Venezuela Fungi, but the name was never published.

Venezuela; Hungary, South Africa, Ceylon, Java.

#### 5. DIDERMA SIMPLEX (Schroet.) List.

Mycetozoa ed. 2. 107.

Pl. VIII, Figs. 182, 183.

1885. *Chondrioderma simplex* Schroet., in Cohn, Krypt.-Fl. Schles. 3 (1) : 123.

Sporangia gregarious, sessile, globose or depressed-globose, 0.3–0.5 mm. in diameter, or sometimes plasmodiocarpous; brown or brick-red when fresh, fading to ochraceous with age; hypothallus everywhere in evidence; columella ill-defined; capillitium scanty, the threads delicate, pale, branching as they join the peridial wall; spores dull violaceous, slightly roughened, 8–10  $\mu$ . Plasmodium yellow-brown.

A rather crude, primitive representative of this beautiful genus. The inner peridium seems to be lacking—a comfort to Rostafinski! Rare. Our best specimens are from New Jersey, by courtesy of Dr. C. L. Shear. These went to fruit on leaves and branches of *Vaccinium*. It seems to affect the heather of Europe, moorland, etc. We have also specimens from the herbarium of Mr. Bilgram. In no American gathering examined does the capillitium show calcareous thickenings as described by the British text. Meylan suggests that the American forms are specifically distinct from those of Europe.

The var. *echinulatum* Meylan is described as having bright yellow sporangium and columella and more spinulose spores.

Rare in North America—New Hampshire, New Jersey, Pennsylvania, North Carolina, Chile; Europe.

#### 6. DIDERMA SPUMARIOIDES Fries

Syst. Myc. 3 : 104. 1829.

Pl. VIII, Figs. 184, 185.

1818. *Didymium spumarioides* Fr., Symb. Gast. 20.

1833. *Physarum stromateum* Link, Handb. 3 : 409.

1849. *Carcarina spumarioides* Fr., Summ. Veg. Scand. 451.

1875. *Chondrioderma spumarioides* (Fr.) Rost., Mon. 174.

1876. *Chondrioderma stromateum* (Lk.) Rost., Mon. App. 18.

1892. *Chondrioderma virgineum* Masec, Mon. 207.

1894. *Diderma stromateum* (Lk.) Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 152.

1894. *Diderma cinereum* Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 154.

Sporangia sessile, white, crowded, spherical or by mutual pressure irregular; peridium plainly double, but the layers adhering, the outer more strongly calcareous, but very frail, almost farinaceous; hypothallus more or less plainly in evidence, white or pale alutaceous; columella distinct, though often small, globose, white or yellowish; capillitium variable in quantity, sometimes abundant, brown, somewhat branching and anastomosing outwardly, the tips paler; spores distinctly but rather sparsely warted, dark violaceous, 8–11  $\mu$ .

This species has the outward seeming of a didymium, but is plainly different as that genus is here defined, since the calcareous crust, although inclined to be pulverulent, is made up of minute granules, not crystals, of lime. The hypothallus is sometimes hardly discoverable, sometimes well developed, rugulose, extending far beyond the limits of the fructification. In the Monograph, p. 175, Rostafinski includes here *Physarum stromateum* Link. In the Appendix he is inclined to raise Link's form to the dignity of a distinct species, basing the diagnosis upon the superposition of the sporangia in certain cases, a feature entirely unknown to Link's description and of extremely uncertain value, since by their crowding the sporangia are likely always to be pushed above each other. We therefore regard *Chondrioderma stromateum* (Link) Rost. as a synonym of the present species, as the original description, so far as it goes, indicates.

Forms in which the hypothallus is lacking or poorly developed were formerly placed in *D. cinereum* Morgan, but there is a perfect transition between such forms and the typical phase.

Widely distributed in North America and Europe. Also reported from Bolivia, Chile; Ceylon, Java, Manchuria, Japan.

#### 7. *DIDERMA CRUSTACEUM* Peck

Rept. N. Y. State Museum 26 : 74. 1874.

Pl. IX, Figs. 186, 187.

1888. *Chondrioderma crustaceum* (Pk.) Berlese, in Sacc., Syll. Fung. 7 : 373.

1899. *Chondrioderma globosum* (Pers.) Rost. ex Lister, Mycetoza 78, in part.

1911. *Diderma globosum* Pers. ex List., Mycetoza ed. 2. 104, in part.

Sporangia closely crowded or superimposed, in a cushion-like colony, creamy white or occasionally pinkish, globose, embedded in the substance of the hypothallus, the outer peridium smooth, delicate, crustaceous, fragile, remote from the blue iridescent inner membrane; hypothallus prominent; columella variable, generally present, globose; capillitium dark colored, the threads branching and combining to form a loose net; spore-mass black; spores by transmitted light dark



violaceous, distinctly warted, 12–15  $\mu$ . Plasmodium at first watery, colorless, becoming at length milky white.

The didermas are generally delicately beautiful. The outer wall in the present species is like finest unglazed china, softly smooth, and yet not polished, often absolutely white, with porcellaneous fracture. An interparietal space separates the outer from the inner wall, so that the former may be broken, bit by bit, without in the least disturbing the underlying structure. The inner wall is ashen or gauzy iridescent-green, sending back all colors in reflected light. The spores are violet, deeply so when fresh, the capillitium strong and likewise tinted; the columella passing down and blending with the common snow-white hypothalline base. In the Lister monograph included with *D. globosum* but the two species are distinctly different in habit. In the one the distinct sporangia are associated but not crowded; in the other all are massed together, forming chalky masses of considerable size, 2 or 3 cm., overcrowded, superimposed, where the sporangia are irregular in shape and size by reason of mutual pressure. The plasmodium develops in forests and orchards, among decaying leaves, but is inclined to rise as maturity draws near, to ascend some erect twig, or the stem of a living plant to the height of several inches where the sporangia at length appear "heaped and pent," an encircling sheath, conspicuous after the fashion of *Mucilago*, for which it is indeed sometimes mistaken.

Common. Distinguished from the following species by the larger and more distinctly marked spores and the more crowded habit. New England and Ontario west to Nebraska; Europe.

The species reported from Manchuria by Skvortzow (1931), as *D. globosum*, is said to have spores 11–11.5  $\mu$ . It is probably this species.

#### 8. DIDERMA GLOBOSUM Pers.

Roemer N. Mag. Bot. 1 : 89. 1794.

Pl. IX, Figs. 188, 189.

1804. *Reticularia globosa* (Pers.) Poiret, in Lam. Encycl. 6 : 182.

1827. *Cionium globosum* (Pers.) Spreng., Syst. Orb. Veg. 4 : 529.

1875. *Chondrioderma globosum* (Pers.) Rost., Mon. 180.

1876. *Chondrioderma affine* Rost., Mon. App. 18.

1876. *Chondrioderma similans* Rost., Mon. App. 20.

Sporangia more or less closely gregarious, sessile, globose or by mutual pressure prismatic or polyhedral, white, the outer wall smooth, polished, crustaceous, fragile, far remote from the inner, which is thin, smooth or rugulose, iridescent-blue; hypothallus usually pronounced and spreading beyond the sporangia, sometimes scanty or



lacking; columella white, variable, sometimes very small, inconspicuous, sometimes large, globose, ellipsoidal, even pedicellate; capillitium abundant, brown or purplish brown, branching and occasionally anastomosing to form a loosely constructed superficial net; spores globose, delicately spinulose,  $7.5-10\ \mu$ .

As noted under *D. crustaceum*, Lister includes that species in the present one and gives the spore measurements as  $10-14\ \mu$ , rather a wide range. But Rostafinski said  $8.3\ \mu$ , the fraction indicating caution, as though it were the average of several measurements. We do have the small-spored form, although it is rare, and it may be what Rostafinski had in mind. In some of our material the spores attain  $10\ \mu$  and the measurements are changed in accordance with this conception of the species.

Rare. Ohio, Wisconsin, Iowa, Washington; Hungary, Rumania, North Africa.

#### 9. *DIDERMA LYALLII* (Masse) Macbr.

N. A. Slime-Moulds 99. 1899.

Pl. IX, Figs. 190, 191.

1892. *Chondrioderma lyallii* Masse, Mon. 201.

1911. *Diderma niveum* (Rost.) Macbr. var. *lyallii* Lister, Mycetoza ed. 2. 105.

Sporangia obovate, more or less closely crowded, white, creamy or pallid carneous, substipitate, about 1 mm. in diameter; outer peridium firm, stout, encrusted, especially above, with granular masses of lime, the inner well developed, close to the outer, more or less cartilaginous, opaque, yellow or buff colored; hypothallus well developed, venulose, white, passing up unchanged to form the short, stout stipe and lower outer peridium; columella prominent, half the height of the sporangium, flesh colored or brown; capillitium of short, brown threads, rigid, much branched, forming a net, widened irregularly and especially at the nodes; spore-mass black; spores by transmitted light dark brown, rough,  $14-17\ \mu$ .

A very distinct species, the large, fine, showy sporangia in more or less crowded clusters springing from a snow-white, common hypothallus. First reported from western Canada, it has since been found throughout the region from the Rocky Mountains to the Pacific. Meylan believes it should be grouped with the leangiums. Occasionally the outer peridium is broken up into calcareous plates, as in *Lepidoderma*. Specimens from Rumania, distributed by Brandza, No. 97, show an extreme development of this tendency.

Western United States and Canada, Chile; Europe.

## 10. DIDERMA NIVEUM (Rost.) Macbr.

N. A. Slime-Moulds 100. 1899.  
Pl. IX, Figs. 192, 193.

- 1829. *Diderma deplanatum* Fr., Syst. Myc. 3 : 110.
- 1849. *Leocarpus deplanatus* Fr., Summ. Veg. Scand. 450.
- 1875. *Chondrioderma niveum* Rost., Mon. 170.
- 1875. *Chondrioderma physaroides* Rost., Mon. 170.
- 1876. *Chondrioderma deplanatum* (Fr.) Rost., Mon. App. 17.
- 1877. *Diderma albescens* Phill., Grev. 5 : 114.
- 1892. *Chondrioderma albescens* (Phill.) Masee, Mon. 209.

Sporangia gregarious, scattered, or more often crowded, sessile, depressed-spherical, sometimes ellipsoidal or elongate, white, the outer peridium crustaceous, chalky, smooth and fragile, the inner distinct, delicate, ochraceous; hypothallus scant or none; columella well developed, globose or hemispherical, orange-tinted or ochraceous; capillitium abundant, made of threads of two sorts, some purplish or dusky, with pale extremities, uneven, others more delicate and colorless, and with wart-like thickenings, all sparingly branched; spores violet-brown, minutely roughened, 9–13  $\mu$ .

This species is not common. From Colorado we have fine specimens typical in every way. Specimens from Washington are flatter, and may represent *D. deplanatum* Fr. In the Mycetozoa ed. 3. 90, Miss Lister treats this as a distinct species, distinguishing it from *D. niveum* by its plasmodiocarpous habit and absence of columella. But in the description it is stated "Columella hardly developed or broadly convex, orange" which seems to leave the distinction uncertain, to say the least. Furthermore, in the American collections there is no correlation between the small spores and the flattened columella, the latter being rather associated merely with the plasmodiocarpous phase. This is less true of the European collections at hand, but most of them are obviously incomplete developments, with many giant and imperfectly matured spores. If the two species are finally proved to be identical, Fries' name must take precedence. Pending such final proof, we retain the more familiar name.

Colorado, Washington, Oregon, California; Europe.

*Diderma microcarpum* Meylan (Bull. Soc. Vaud. Sc. Nat. 55 : 240, 1924) is certainly very close to the preceding species, although the author regards it as distinct. The sporangia are smaller, 0.3–1 mm. in diameter, the peridial layers rarely separated, the spores 10–11  $\mu$ .

11. *DIDERMA TESTACEUM* (Schrad.) Pers.

Syn. Meth. Fung. 167. 1801.

Pl. IX, Figs. 194, 195.

1797. *Didymium testaceum* Schrad., Nov. Gen. Plant. 25.  
 1827. *Cionium testaceum* Spreng., Syst. Orb. Veg. 4 : 529.  
 1869. *Diderma cubense* Berk. & Curt., Jour. Linn. Soc. 10 : 347.  
 1873. *Chondrioderma testaceum* (Schrad.) Rost., Vers. 13.  
 1873. *Diderma sublateritium* Berk. & Br., Jour. Linn. Soc. 14 : 82.  
 1874. *Diderma maria-wilsoni* Clinton, Rept. N. Y. State Mus. 26 : 74.  
 1876. *Chondrioderma sublateritium* (Berk. & Br.) Rost., Mon. App. 19.  
 1876. *Chondrioderma cubense* (Berk. & Curt.) Rost., Mon. App. 19.

Sporangia gregarious, sessile, depressed-spherical or sometimes elongate, small, 1 mm. or less, rose-white, smooth, the outer peridium crustaceous, rather thick and persistent, polished, slightly raised above the inner, which is dull ashen and more or less wrinkled; hypothallus none; columella prominent, hemispherical in the typical rounded forms, slightly rough, reddish or reddish alutaceous; capillitium usually abundant, of slender, delicate, pale or colorless threads, little branched, smooth; spores violaceous brown, minutely roughened, 8–9  $\mu$ .

Easily recognized when fresh by its delicate pink or roseate color; weathered specimens tend to become white, and might be confused with forms of *D. effusum*, but the sporangia in the present species are less flattened and only rarely and in special situations exhibit the linear or plasmodiocarpous shapes characteristic of *D. reticulatum*. All our specimens from the west are on dead leaves of oak; eastern gatherings are on moss, beech, maple and aspen leaves and occasionally on woody débris.

Not common but widely distributed—New England to Washington, California, South Carolina; Europe, North Africa, Japan, Ceylon.

12. *DIDERMA HEMISPHERICUM* (Bull.) Hornem.

Fl. Dan. 33 : 13. 1829.

Pl. IX, Figs. 196, 197.

1791. *Reticularia hemisphærica* Bull., Champ. 93.  
 1803. *Physarum depressum* Schum., Enum. Pl. Sæll. 2 : 202.  
 1804. *Reticularia contorta* Poirét, in Lam. Encycl. 6 : 182.  
 1829. *Didymium hemisphæricum* (Bull.) Fr., Syst. Myc. 3 : 115.  
 1832. *Didymium michelii* Lib., Pl. Ard. fasc. II, 180.  
 1842. *Physarum michelii* (Lib.) Corda, Icon. Fung. 5 : 57.  
 1873. *Chondrioderma michelii* (Lib.) Rost., in Fuckel, Symb. Myc. Nachtr. 74.  
 1894. *Diderma michelii* (Lib.) Morg. Jour. Cin. Soc. Nat. Hist. 16 : 153.  
 1909. *Chondrioderma hemisphæricum* (Bull.) Torrend, Fl. Myx. 163.

Sporangia gregarious, orbicular, discoid, depressed above and often umbilicate below, stipitate or sometimes sessile, the outer peridium

white, fragile, crustaceous, soon breaking about the margins, closely applied to the inner, which is delicate, cinereous and ruptures irregularly; stipe about equal to the diameter of the sporangium, 1 mm., rather stout, calcareous, nearly white or pallid to brownish or alutaceous, more or less wrinkled longitudinally, the wrinkles, when present, forming veins on the lower surface of the sporangium; hypothallus small; columella not distinct from the thickened brownish or reddish base of the sporangium; capillitium of delicate threads, mostly simple and colorless, often scanty; spores pale violaceous, nearly smooth, 8–9  $\mu$ . Plasmodium opaque white.

A very well-marked species, easily recognized, at least when stipitate, by its remarkable discoid or lenticular sporangia. The name *hemisphaericum* is unsuitable, as the sporangia are not hemispherical. After the spore dispersal, the stipes are long-persistent, surmounted by a peculiar disk representing the consolidated columella, lower sporangial wall, and expanded stem-top. Sessile specimens are like similar forms of *D. reticulatum*, but in all the gatherings before us the stipitate type is at hand to reveal the identity of the species.

Rostafinski's figs. 131, 146, 149, and 150, adapted from Corda, exaggerate the hypothallus, but otherwise leave nothing to be desired.

As to synonymy, Bulliard has plainly the priority. His figure, pl. 446, fig. 1, can refer to nothing else, especially reënforced as it is by Sowerby, Eng. Fung. Pl. 12.

Rather rare on fallen stems of herbaceous plants, but widely distributed, New England to Oregon and Washington, Puerto Rico, Argentina; Europe, South Africa, Ceylon, Java, Japan.

### 13. DIDERMA MONTANUM Meylan

Bull. Soc. Vaud. Sc. Nat. 53 : 454. 1921.

Pl. IX, Figs. 198, 199.

1910. *Chondrioderma montanum* Meyl., Bull. Soc. Bot. Genève 2 : 262.

Sporangia scattered or in groups, subglobose, stalked, flattened or umbilicate beneath, pearl or pinkish gray or nearly white, smooth or somewhat wrinkled, 0.6–0.8 mm. in diameter; sporangium wall of two often separating layers, the outer densely charged with lime granules, the inner reddish brown throughout or towards the base; stalk pale or bright brownish yellow, slender or stout, enclosing white lime deposits, 0.1–0.8 mm. high; columella small, globose or hemispherical, brownish red, sometimes stalked; capillitium of slender purplish or



hyaline threads, branched and anastomosing toward the extremities; spores pale brownish purple, faintly spinulose, 8–10  $\mu$ .

New York, Colorado; Europe.

Var. *album* G. Lister (= *Chondrioderma radiatum* var. *album* Torrend), with white or bluish white sporangia and white or creamy columellæ, and var. *roseum* Meylan, with pale pink sporangia and stalks and dull pink columellæ, occur locally in Europe.

#### 14. *DIDERMA SAUTERI* (Rost.) Macbr.

N. A. Slime-Moulds 103. 1899.

1875. *Chondrioderma sauteri* Rost., Mon. 181.

1891. *Chondrioderma aculeatum* Rex, Proc. Acad. Nat. Sc. Phila. 390.

Sporangia scattered, gregarious, sessile, lenticular or hemispherical, flattened above and sometimes concave or umbilicate below, pale brownish or pinkish gray or dull ochraceous, the outer peridium papyraceous, thin, occasionally wrinkled, rupturing irregularly, remote from the inner, which is thin, delicate, semi-transparent, grayish, rarely iridescent; hypothallus none; columella irregular, sometimes small and hardly evident, rugose, with spine-like processes, the persisting bases of the capillitial threads reddish brown; capillitium scanty, white or colorless, simple or sparingly branched; spores dark violaceous, spinulose, 12–13  $\mu$ .

After careful comparison of specimens and various descriptions, especially that of Rostafinski, with the type specimens of Rex, we concur with Lister in adopting Rostafinski's name. The sporangia in Rex's type specimens are on moss, borne at the extreme tips of acuminate or aculeate leaves, so that at first sight they appear stipitate.

Apparently rare. Maine, New York; Europe.

#### 15. *DIDERMA OCHRACEUM* Hoffm.

Deutsch. Fl. Crypt. Pl. 9, Fig. 2 b. 1795.

1804. *Reticularia ochracea* (Hoffm.) Poir., Lam. Encycl. 6 : 182.

1885. *Chondrioderma ochraceum* Schroet., Cohn Krypt. Fl. Schles. 3 (1) : 124.

Sporangia gregarious or clustered, 0.7–1 mm., sessile, globose or sometimes plasmodiocarpous, ochraceous or olivaceous, yellow; outer wall cartilaginous with yellow deposits of lime, the inner also yellow, adherent or free; columella not distinct; capillitium simple or branching, purple-brown, hyaline at base; spores spinulose, purplish gray, 9–11  $\mu$ .

Brandza states that when the sporangia mature under dry conditions the wall is single and the fructifications resemble sessile forms of *Lepidoderma tigrinum*.

Reported from Massachusetts; also Europe, Japan.

16. *DIDERMA COR-RUBRUM* *Macbr.*

N. A. Slime-Moulds ed. 2. 140. 1922.

1925. *Diderma montanum* Meylan ex Lister, Mycetozoa ed. 3. 83, in part.

Sporangia gregarious, clustered, small, 0.5–0.7 mm., sessile, corrugate-plicate, especially above, snow-white, the outer peridium cartilaginous, polished without and within, the inner delicate, evanescent; columella well developed, globose or clavate, anchored by several stout transverse trabeculae to the peridial wall, papillate, deep red as is the peridium, especially below; capillitium very delicate, sparingly branching, colorless; spores verruculose, fuliginous, tinged with red, about 12  $\mu$ .

This curious but elegant little species is represented by a single colony collected by Professor Morton Peck on rotten wood in Iowa. It resembles *D. sauteri* but is distinguished by the plicate white wall, the stout columella with its lateral extensions, as by the more delicate spores. Miss Lister includes it in *D. montanum*, from which the description would seem to exclude it. The type and only collection is in the British Museum, but it is to be hoped that it will appear again in the original locality.

Iowa.

17. *DIDERMA TREVELYANI* (*Grev.*) *Fr.*

Syst. Myc. 3 : 105. 1829.

Pl. IX, Figs. 200, 201.

1825. *Leangium trevelyani* Grev., Scot. Crypt. Fl. 132.1842. *Polyschismium trevelyani* (Grev.) Corda, Icon. Fung. 5 : 20.1875. *Chondrioderma trevelyani* (Grev.) Rost., Mon. 182.1875. *Chondrioderma ærstedtii* Rost., Mon. 184.1877. *Diderma geasterodes* Phill., Grev. 5 : 113.1877. *Diderma laciniatum* Phill., Grev. 5 : 113.1892. *Chondrioderma geasteroides* (Phill.) Massee, Mon. 201.

Sporangia scattered, globose or nearly so, smooth or verruculose, yellow-brown, reddish brown or rufescent, sessile or short-stipitate; peridium firm, splitting more or less regularly into unequal, revolute, petal-like lobes which are white within, composed of three layers, a thin cartilaginous outer layer and a membranous inner layer, connected by a thick calcareous middle layer composed of coarse, somewhat crystalline lime clusters, the outer layer often splitting to form plates suggesting *Lepidoderma*; stipe, when present, equal, furrowed, concolorous; columella small or none; capillitium abundant, the threads rather rigid, purple or purplish brown, branching and anastomosing, more or less beaded; spores dark, violaceous brown, spinulose, 11–14  $\mu$ .

In 1876, Harkness and Moore collected in the Sierra Nevada Mountains of California forms of *Diderma* which are described by Phillips (Grev. 5 : 113) as *D. geasterodes* and *D. laciniatum*. English authorities who have examined the material agree that the forms described constitute but a single species, and Lister makes them identical with *D. trevelyani* (Grev.) Fr. Rostafinski's figs. 161, 162, are evidently reproduced from Fries. Nees von Esenbeck's pl. IX, fig. 4, also represents this species. Masee describes a columella; Lister says there is none. As a matter of fact, the same cluster of sporangia may show some with a columella and some without. In a collection of Morgan's from Ohio, labelled *Lepidoderma geaster* Link, which seems to belong here, the columellas are uniformly well developed.

The variety *nivale* Meylan (Bull. Soc. Vaud. 50 : 189, 1914) is a large, mottled, rugose, often plasmodiocarpous form, occurring in the Swiss Alps.

Ohio, Colorado, Washington, Oregon, California, Argentina, Chile; Europe.

#### 18. *DIDERMA ASTEROIDES* Lister

Mycetozoa ed. 2. 113. 1911.

Pl. IX, Figs. 202, 203.

1902. *Chondrioderma asteroides* List., Jour. Bot. 40 : 209.

Sporangia globose or ovoid-globose, the apex more or less acuminate, sessile, sometimes narrowed at the base to a short, thick stalk, brown- or chocolate-tinted, marked at the apex by radiant lines, and at length dehiscent by many reflexing lobes revealing the snow-white adherent middle peridium on the exposed or upper side, the membranous inner peridium often remaining about the spore-mass; columella also white, globose or depressed-globose; capillitium generally colorless, somewhat branched, especially above; spores dark violaceous, verruculose, 10-12  $\mu$ .

A very beautiful species, recognizable at sight when unopened by the peculiar chocolate brown color; the sporangia smaller than in *D. radiatum*. When opened, the snow-white flower-like figure, flat against the substratum, is definitive. Very near *D. trevelyani* but the dehiscence is more regular, and the middle crystalline layer is lacking in the sporangium wall.

Var. *luteum* Meylan differs from the typical form in its chamois or yellowish color.

Colorado, Washington, Oregon, California; Europe.

19. *DIDERMA ANTARCTICUM* (Speg.) Sturgis

Mycologia 8 : 37. 1916.  
(as *D. antarctica*)

1887. *Licea antarctica* Speg., Bot. Acad. Nac. Cienc. Cord. 11 : 56.

Sporangia crowded, sessile, subglobose, smooth, mottled brown, 0.7–1 mm. in diameter; sporangium wall cartilaginous but brittle, cream colored on the inside, the two layers closely adhering and enclosing deposits of white lime granules; columella large, hemispherical, cream colored, bearing numerous spine-like processes; capillitium rigid, purplish, with irregular membranous expansions; spores dark purplish brown, with a paler band of dehiscence, closely spinulose, often with dark ridges, 11–12  $\mu$ .

Our only specimens are from Professor Plunkett of the University of California at Los Angeles, determined by Miss Lister. The outer peridium is mottled pinkish buff, crustaceous, and the spores are 14–16  $\mu$ . They may represent a distinct species.

Southern California (?), Chile.

20. *DIDERMA IMPERIALE* Emoto

Bot. Mag. Tok. 43 : 172. 1929.  
(as *D. imperialis*)

Sporangia gregarious, hemispherical or appressed, umbilicate below, about 1 mm. in diameter, dusky neutral gray\* to olivaceous black\*, usually sessile, but often stalked, the total height of the stalked sporangia about  $\frac{1}{3}$  mm.; sporangium wall simple, clear brown, encrusted with amorphous calcium granules; stalk dark brown, cylindrical or awl-shaped, striate longitudinally, 0.15 mm. tall; columella lacking; capillitium colorless, sparsely branched, very slender, often bearing calcium granules and round, wart-like, refractive enlargements; spores globose, clear violet-brown, warted, 10  $\mu$ .

The simple sporangium wall indicates the subgenus *Leangium*. The original description states that the capillitium is "about 0.17  $\mu$  thick," an obvious error. The illustration shows it to be very delicate, however, and this feature, and the absence of a columella, seem to be the distinctive characters.

Japan. Known only from a single collection growing on mosses on the trunk of a living *Cryptomeria*.



21. *DIDERMA RADIATUM* (L.) *Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 151. 1894.

Pl. IX, Figs. 204, 205.

- 1763. *Lycoperdon radiatum* L., Sp. Plant. ed. 2. 1654.
- 1797. *Didymium stellare* Schrad., Nov. Gen. Pl. 21.
- 1801. *Diderma stellare* (Schrad.) Pers., Syn. Meth. Fung. 164.
- 1801. *Diderma umbilicatum* Pers., Syn. Meth. Fung. 165.
- 1803. *Diderma crassipes* Schum., Enum. Pl. Sæll. 2 : 196.
- 1804. *Reticularia umbilicata* (Pers.) Poiret, in Lam. Encycl. 183.
- 1809. *Leangium stellare* (Schrad.) Link, Mag. Ges. Nat. Fr. Berl. 3 : 26.
- 1815. *Didymium geaster* Link, Mag. Ges. Nat. Fr. Berl. 7 : 42.
- 1827. *Cionium stellare* (Schrad.) Spreng., Syst. Orb. Veg. 4 : 529.
- 1827. *Cionium umbilicatum* (Pers.) Spreng., Syst. Orb. Veg. 4 : 529.
- 1836. *Diderma carmichaelianum* Berk., in Sm., Engl. Fl. 5 (2) : 311.
- 1869. *Didymium complanatum* Fuckel, Symb. Myc. 341.
- 1873. *Diderma concinnum* Berk. & Curt., Grev. 2 : 52.
- 1875. *Chondrioderma radiatum* (L.) Rost., Mon. 182.
- 1877. *Chondrioderma carmichaelianum* (Berk.) Cooke, Myx. Gt. Brit. 42.

Sporangia scattered, depressed-globose, sometimes also flattened below, stipitate, smooth or slightly corrugate, ashen or brownish drab, rarely reddish or white, about 1 mm. in diameter, the peridium dehiscing irregularly or somewhat radiately from above downwards, the segments reflexed, the inner layer not distinguishable or inseparable; stipe short, stout, brownish, sometimes almost lacking; hypothallus not conspicuous, but sometimes sufficient to connect the bases of adjacent stipes; columella large, hemispherical or globose, pallid or yellowish; capillitium abundant, of slender, generally simple, colored threads, paler at the furcate tips; spores dark violaceous, minutely roughened, 8–11  $\mu$ .

Rare on rotten logs in the forests; September. Easily recognized by the short-stiped, ashen sporangia which before dehiscence indicate by delicate tracings the lines which subsequent cleavage is to follow. In texture the peridium resembles that of *D. floriforme*.

The Linnæan description on which to base the specific name *D. radiatum* is wholly inadequate. It appears also by the testimony of Linné *fil.*, that *Lycoperdon radiatum* L. is a lichen and the name is so applied by Persoon. But in the Linnæan herbarium preserved at London, teste Lister, the original type of *Lycoperdon radiatum* L. may yet be seen to the confusion of *fil.*, Persoon and other followers of Schrader.

The var. *umbilicatum* Meylan (Ann. Cons. Bot. Gen. 1913 : 312) with pale, flattened, umbilicate sporangia, has often been given specific distinction as *D. umbilicatum* Pers.; the var. *rubrum* Rönn (Schr. Nat. Ver. Schles.-Holst. 15 : 59, 1911) is said to have grayish pink spo-

rangia and pink lime deposits. The var. *macrosporum* Meylan (Bull. Soc. Vaud. Sc. Nat. 56 : 68, 1925) is said to have spores 14–15  $\mu$ .

Pennsylvania, Virginia, Ohio, Iowa, Colorado, Montana, Washington, Oregon; Europe generally, North Africa, Australia, India, Japan.

## 22. DIDERMA ROANENSE (*Rex*) *Macbr.*

N. A. Slime-Moulds 104. 1899.

Pl. IX, Figs. 206, 207.

1893. *Chondrioderma roanense* Rex, Proc. Ac. Nat. Sc. Phila. 368.

Sporangia scattered, discoidal, thin, flattened or slightly convex above, plane or plano-concave below, umber-brown, stipitate, the outer peridium smooth, brittle, rupturing irregularly, the basal fragments somewhat persistent, concrete with the inner peridium, which is pure white, except near the columella, and punctate; stipe short, variable, longitudinally ridged, jet-black; hypothallus not evident; columella flat, discoidal, pale ochraceous; capillitium sparse, white or colorless, composed of simple, rarely forked, sinuous threads occasionally joined by lateral branches; spores dark violaceous, minutely but distinctly warted, 12–14  $\mu$ .

This species is readily distinguished by its color. The sporangia, found on rotten wood, are large, 1 mm. in diameter, brown, and have thick, persistent walls. Doctor Rex considered that the species differs from other related forms not only in color, but in the well-marked discoidal columella and the jet-black irregular stipe. It is perhaps most nearly related to *D. radiatum*.

Maine, New Hampshire, Tennessee, Colorado; Switzerland.

## 23. DIDERMA LUCIDUM *Berk. & Br.*

Ann. Mag. Nat. Hist. 3 ser. 7 : 380. 1861.

1877. *Chondrioderma lucidum* (Berk. & Br.) Cooke, Myx. Gt. Brit. 42.

1892. *Chondrioderma carmichaelianum* (Berk.) Cooke ex Mass., Mon. 202, in part.

Sporangia scattered, subglobose, flattened beneath, 0.8 mm. in diameter, usually stalked, orange or vermilion, glossy, with pitted surface, dehiscing irregularly or by four or five lobes that become pale at the margins; outer layer of sporangium wall translucent orange-yellow, with scanty deposits of lime on the inner side, closely connected with the yellow inner layer; stalk slender, subulate, brownish black, 0.2–0.5 mm. high; columella obconic or subglobose, often short-stalked, rugose, white or cream colored, filled with lime granules; capillitium a scanty and irregular network of stout, irregular purple-

brown threads, often expanded at the axils; spores closely and rather coarsely warted, 14–16  $\mu$  in diameter. Plasmodium orange-yellow.

The bright vermilion sporangia, the distinctive capillitium and large spores combine to make this a striking and distinctive species. The above description, adopted in the main from the third edition of the Lister monograph, has been somewhat modified on the basis of the examination of some specimens courteously furnished by Miss Lister.

Rare and local. Wales, England (?), Germany, Ceylon (?). Not known from North America.

#### 24. *DIDERMA FLORIFORME* (Bull.) Pers.

Roem. N. Mag. Bot. 1 : 89. 1794.

Pl. IX, Figs. 208, 209.

- 1791. *Sphaerocarpus floriformis* Bull., Champ. 142.
- 1791. *Stemonitis floriformis* (Bull.) Gmel., Syst. Nat. 2 : 1469.
- 1797. *Didymium floriforme* (Bull.) Schrad., Nov. Gen. Pl. 21.
- 1801. *Lycoperdon floriforme* (Bull.) With., Brit. Pl. ed. 4. 4 : 379.
- 1803. *Diderma spurium* Schum., Enum. Pl. Sæll. 2 : 197.
- 1804. *Reticularia floriformis* (Bull.) Poiret, in Lam. Encycl. 6 : 182.
- 1809. *Leangium floriforme* (Bull.) Lk., Mag. Ges. Nat. Fr. Berl. 3 : 26.
- 1814. *Leangium lepidotum* Ditm., in Sturm., Deutsch. Fl. Pilze 2 : 43.
- 1827. *Cionium floriforme* (Bull.) Spreng., Syst. Orb. Veg. 4 : 529.
- 1827. *Cionium lepidotum* (Ditm.) Spreng., Syst. Orb. Veg. 4 : 529.
- 1829. *Diderma lepidotum* (Ditm.) Fr., Syst. Myc. 3 : 100.
- 1875. *Chondrioderma floriforme* (Bull.) Rost., Mon. 184.

Sporangia crowded, generally in dense colonies, globose, smooth, ochraceous brown, varying from nearly white to umber, stipitate; peridium thick, cartilaginous, splitting from above into several petal-like lobes, which speedily become reflexed exposing the pale brown inner surface of the peridium and swarthy spore-mass, the inner peridium not separable; stipe concolorous, about equal to the sporangium; hypothallus generally well developed, but thin, membranaceous, common to all the sporangia; columella prominent, globose or cylindric, often constricted below, and prolonged upward almost to the top of the spore-case; capillitium of slender, delicate, sparingly branched threads; spores dark violaceous brown, paler on one side and sparsely and irregularly studded with large, blunt warts, 10–11  $\mu$ .

Not uncommon, especially on rotten oak logs. Easily recognized by the peculiar form of the fruit, spherical before dehiscence, floriform after. Unlike most species, this form often fruits in dark places, in the interior of a log, even in the ground.

New England, Ontario to Iowa, Nebraska, Washington and south; Europe.

25. *DIDERMA RUGOSUM* (*Rex*) *Macbr.*

N. A. Slime-Moulds 105. 1899.

Pl. IX, Figs. 210, 211.

1893. *Chondrioderma rugosum* Rex, Proc. Acad. Nat. Sc. Phila. 369.

Sporangia gregarious, scattered, stipitate, white or ashen, rugulose over the whole surface, the ridges marking the lines of subsequent rupture or dehiscence; peridium thin, papyraceous; stipe well developed, equal to or exceeding the sporangium, subulate, almost black; hypothallus none; columella distinct, globose, generally white, sometimes small, sometimes penetrating the sporangium to one-half the height; capillitium white or colorless, the filaments freely forked and combined by lateral branches into a loose network attached to the columella and basal wall below and the upper sporangial wall above; spores violaceous brown, warted, 8–10  $\mu$ . Plasmodium gray.

This species is well designated *rugosum*, and is recognizable at sight by its wrinkled, areolate surface. Related to *D. radiatum* in the prefigured dehiscence, but otherwise very distinct. Likely to be overlooked as a prematurely dried physarum.

Var. *sessile* Brandza (Bull. Soc. Myc. Fr. 44 : 266, 1929) as described, differs so greatly from the typical form as to suggest specific distinction. The sporangia are small, 0.4–0.8 mm., sessile, the peridium distinctly double, the columella usually rudimentary or lacking, the spores 12–14  $\mu$ .

Var. *asiatica* Skvortzow 1931, does not seem to differ from the typical form in any significant respect.

Rare. North Carolina, Florida, Iowa, West Indies; Europe, Asia.

5. *Wilczekia Meylan*

Bull. Soc. Vaud. Sc. Nat. 56 : 68. 1925.

Sporangia ovoid, elliptical or subspherical, often somewhat compressed transversely; peridium simple, membranous, the entire surface covered with amorphous lime granules and plasmodic particles; capillitium of branched and anastomosing colored filaments similar to those of the Didymiaceæ; columella present or absent; spores blackish brown. Described as having the capillitium and columella of *Diachea*, but differing from that genus and from *Leptoderma* in the opaque limy peridium wall.

A single species:



*WILCZEKIA EVELINÆ Meylan*

Bull. Soc. Vaud. Sc. Nat. 56 : 69. 1925.

Sporangia sessile, ovoid or elliptical, rarely subspherical, often compressed transversely, 0.3–0.5 mm. tall, dull gray, somewhat rugulose or furrowed, darker or brownish below, usually grouped in twos or threes; peridium membranous, single, the entire surface covered with brownish plasmodic particles, and irregular or more or less star-like calcareous granules 2–4  $\mu$  in diameter; capillitium of branched, anastomosing filaments, similar to those of *Didymium*, of the same color as the spores except at the extremities, which are hyaline, so that the surface of the capillitial mass is grayish, the forkings forming triangular enlargements sometimes containing the same materials as those deposited on the peridium; columella usually lacking, sometimes well developed and then calcareous; spores sooty, dull, scarcely transparent, spiny, 9–11  $\mu$ .

The dehiscence is irregular, by the fragmentation of the upper part of the peridium, the capillitium, which adheres to the peridium only at the base, retaining its shape as in some species of *Physarum*. The author speaks of "amorphous crystals" of lime, and later of "calcareous crystals of irregular form or star-shaped or granular." The inference is that they are not regularly star-shaped, as in *Didymium*.

Jura Mountains, Switzerland.

**6. *Lepidoderma de Bary***

*in* Rost. Versuch 13. 1873.

Sporangia stalked, sessile or plasmodiocarpous; peridium cartilaginous, more or less covered with large calcareous scales which are either superficial or immersed in lenticular cavities; capillitium non-calcareous.

The crystalline scales are soluble in weak hydrochloric acid, and are enclosed in a delicate sac. Could the outer peridium be seen in process of formation it would probably be found to be made up of an ectosarcous foam in whose cavities the excreted calcium is crystallized.

The taxonomy of this small genus is difficult. *L. tigrinum*, the commonest species, is rather clearly marked, but descriptions of the other species are not in agreement, and sometimes specimens distributed by those who have published on them are not in entire accord with the descriptions. The following treatment is based on a careful comparison of the material available with the published descriptions.

## KEY TO THE SPECIES OF LEPIDODERMA

- a. Sporangia stipitate, stipe bright orange-brown; rarely sessile on an orange-brown hypothallus. . . . . 1. *L. tigrinum*
- a. Typically sessile or plasmodiocarpous; rarely stipitate and stipe then dark. . . . . b
  - b. Subglobose, pulvinate or short-plasmodiocarpous; spores 10–13  $\mu$ . . . . . 2. *L. chaillatii*
  - b. Typically plasmodiocarpous; spores usually larger. . . . . c
- c. Spores 15–18  $\mu$ ; capillitium usually vesicular. . . . . 3. *L. granuliferum*
- c. Spores 11–15  $\mu$ ; capillitium not vesicular. . . . . 4. *L. carestianum*

1. *LEPIDODERMA TIGRINUM* (Schrad.) Rost.

Versuch 13. 1873.

Pl. X, Figs. 212, 213.

- 1797. *Didymium tigrinum* Schrader, Nov. Gen. Plant. 22.
- 1801. *Physarum squamulosum* Pers., Syn. Meth. Fung. 174.
- 1801. *Physarum tigrinum* Pers., Syn. Meth. Fung. 174.
- 1808. *Trichia squamulosa* Poiret, Lam. Encycl. 8 : 53.
- 1808. *Trichia tigrina* Poiret, Lam. Encycl. 8 : 53.
- 1827. *Leangium squamulosum* Fr., Stirp. Femsj. 83.
- 1829. *Didymium rufipes* Fr., Syst. Myc. 3 : 116.
- 1836. *Diderma citrinum* Berk., Sm. Engl. Flora 5 (2) : 310, non Fr.
- 1892. *Lepidoderma fulvum* Mass., Mon. 253.

Sporangia scattered, rather large, often 1–2 mm. in diameter, hemispherical-depressed, stipitate, umbilicate beneath; peridium shining, olivaceous or purplish, tough, covered more or less abundantly with flat, circular or angular scales; stipe 1–2 mm. tall, stout, furrowed, dark brown, but containing calcareous deposits, tapering upward, and continued within the peridium as a pronounced more or less calcareous columella; hypothallus more or less prominent, yellowish or brownish; capillitium dark, purplish brown, of sparingly branching threads radiating from the columella; spores dull purplish brown, minutely spinulose, 10–13  $\mu$ . Plasmodium orange.

A singular species, easily recognized by its peculiar, placoid scales, large and firmly embedded in the peridial wall. The internal structure is essentially that of *Diderma* or *Didymium*. The species occurs in hilly or mountainous regions, on moss-covered logs. The plasmodium is yellow, some part of it not infrequently remaining as a venulose hypothallus connecting such sporangia as are near together.

Meylan records a dwarf phase, form *microcarpon*, with sporangia only 0.5 mm. in diameter, from the Alps, also a form *gracile*, with long slender stem, from the Jura Mountains.

New England to British Columbia and Oregon; rare in the east, common on the Pacific coast; Europe, Japan.

2. *LEPIDODERMA CHAILLETII* Rost.

Mon. 189. 1875.

1911. *Lepidoderma carestianum* Rost. var. *chailletii* (Rost.) List., Mycetozoa ed. 2. 140.

Sporangia subglobose or pulvinate, or forming short plasmodiocarps, crowded and more or less coalescent, or merely gregarious, large, 1–1.5 mm. broad, drab or dull gray, sparsely sprinkled with white tetrahedral or irregular scales; peridium thin, more or less translucent, rugulose, dull brown or yellowish, persistent; columella clavate or scarcely developed; capillitium abundant, under the lens purple-brown, sparingly branched, even, slender, without calcareous deposits or vesicles; spores minutely warted, fuliginous, 10–13  $\mu$ . Plasmodium dirty white.

Similar to *L. carestianum*, but differing in the size and habit of the sporangia, in the more uniform capillitium and in the size, color and surface characters of the spores.

Washington, California; Europe.

3. *LEPIDODERMA GRANULIFERUM* (Phill.) R. E. Fr.

Arkiv för Bot. 6 (7) : 3. 1906.

Pl. X, Figs. 214, 215, 216.

1877. *Didymium granuliferum* Phill., Grev. 5 : 114.  
 1891. *Amaurochaete minor* Sacc. & Ell., Michelia 2 : 566.  
 1892. *Badhamia granulifera* (Phill.) Massee, Mon. 321.  
 1911. *Lepidoderma carestianum* (Rabenh.) Rost. var. *granuliferum* Lister, Mycetozoa ed. 2. 140.

Sessile, plasmodiocarpous, the peridium dark, covered with dull cinereous scales, appearing light drab under lens; columella small, dark; capillitium rough, dark or pale and often with vesicular expansions at the axes, which enclose calcareous deposits; spores clear brown, rather sparsely covered with distinct dark warts, 15–20  $\mu$  in diameter.

A puzzling form, very variable, and undoubtedly approaching *L. carestianum*, but apparently differing constantly in the very large spores. The marking of the latter differs from the marking on the spores of *carestianum* in that the warts are longer and more slender, more spinulose. Lister emphasizes the calcareous inclusions in the capillitium, but this feature seems to be inconstant. Phillips' original description gives the spore measurements as 22–25  $\mu$ , larger than in any of the material so referred in our collection. Harkness No. 35,

from Utah, in Ellis collection, N. Y. Bot. Gard., belongs here. A collection from Washington, which otherwise seems to belong here, has short, irregular, brownish stipes.

Washington, California, Utah; Sweden, Switzerland. Alpine, and apparently uncommon.

#### 4. *LEPIDODERMA CARESTIANUM* Rost.

Mon. 188. 1875.

Pl. X, Figs. 217, 218, 219.

1862. *Reticularia carestiana* Rabenh., Fung. Eur. Ex. No. 436. Not published.

Fructification in the form of flat, pulvinate plasmodiocarps, or rarely sporangiate, the sporangia sessile, ellipsoidal, elongate, irregular, confluent, brown or brownish gray, the peridium covered more or less completely with dull white or yellowish crystal-like scales; columella, where visible, yellowish brown, calcareous; capillitium coarse, rigid, more or less branched and united, or colorless, delicate, forming a definite net; spores distinctly warted, purple, 11–15  $\mu$ . Plasmodium black.

The plasmodial colors of this species and *L. chaillatii* are quoted from Lister with some misgiving, since the other characters of these two species are based upon Meylan's treatment, which seems more in accord with the material available for study. The difference in spore-size between the two species is not distinctive, since the ranges overlap, but in general, the sporangiate forms have small spores and the plasmodiocarpous forms large spores, while the average spore-size of *L. granuliferum* is well beyond either. *Amaurochæte minor* Sacc. & Ell., cited by Lister as a synonym of the present species, is represented in the Ellis collection at the New York Botanical Garden by two collections made by Harkness in Utah. The spores range from 15–18  $\mu$  in diameter, averaging 16.3  $\mu$ . In this and in other respects, the material agrees with *L. granuliferum* as here understood.

New Hampshire, Washington, California; Europe.

*Lepidoderma mandshurica* Skvortz. (Phil. Jour. Sc. 46 : 88, 1931) is described as follows: "Sporangia forming short, subglobose or elongate pulvinate plasmodiocarps, 0.5 mm. to 5 cm. long, 0.5 to 5 mm. broad, silvery gray, clothed with brilliant brownish threads, branched and anastomosing. Spores brown-violet, smooth, 6.8 to 7.2  $\mu$ ." The illustrations show a flattened, pulvinate, circular to irregularly expanded fructification. Apparently differing from *L. carestianum* Rost. mainly in the gray color and the much smaller spores.



7. *Leptoderma* G. Lister

Jour. Bot. 51 : 1. 1913.

Fructification sporangiate, the walls membranous above, thickened with dark granular deposits below; calcareous deposits restricted to scales embedded among the basal granules; capillitium netted; spores purplish gray.

A single species:

*LEPTODERMA IRIDESCENS* G. List.

Jour. Bot. 51 : 1. 1913.

Sporangia scattered or loosely clustered, subglobose, sessile or rarely short-stalked, grayish purple, glossy, iridescent, 0.5–0.8 mm. in diameter; sporangium wall nearly hyaline above, purplish below, where it is thickened with granular deposits and refuse material, often including crystalline flakes of lime 2–15  $\mu$  in diameter; stalk, when present, stout, dark, spreading below into a dark hypothallus; columella present or absent, dark and convex when present; capillitium a persistent network of arching or flexuose dark purple threads radiating from the base, the tips and bases colorless or pale, the latter often expanded or tubular and sometimes enclosing granular matter; spores purplish gray, spinulose, 10–11  $\mu$ . Plasmodium gray or drab.

Certain collections from Oregon and California possibly represent somewhat aberrant forms of this species. The fructifications vary from subglobose sporangia to short plasmodiocarps. The lime is restricted to the basal portion or even to the hypothallus, but does show occasional crystalline plates. The spores are a trifle large, 11–13  $\mu$ .

Oregon? California? Europe.

## ORDER STEMONITALES

Fructification wholly non-calcareous, except in a single genus (*Diachea*) in which the stipe and columella, but neither the capillitium nor the peridium, are calcareous; capillitium threadlike, of anastomosing branches either arising from a well-developed columella or radiating from the base; spores in mass usually black or purple-brown, less commonly ferruginous.

## KEY TO THE FAMILIES OF THE STEMONITALES

- a. Outer wall of peridium gelatinous; sporangiate; columella lacking.....COLLODERMACEÆ
- a. Peridium membranous, often early fugacious; æthalioid or

- sporangiate; columella typically well developed, rarely rudimentary or lacking..... *b*
- b.* Fructification æthalioid or of separate sporangia; columella usually prominent, giving rise to a branched capillitium; in a few forms columella and capillitium poorly defined..... STEMONITACEÆ
- b.* Sporangia always distinct; capillitium developed chiefly or only from the summit of the columella..... LAMPRODERMACEÆ

## FAMILY COLLODERMACEÆ

Sporangiate, sessile or stalked, limeless; peridium duplex, the inner wall membranous, the outer, gelatinous when moist, with superficial granular deposits, hard and brittle when dry; capillitium intricate.

A single genus:

*Colloderma G. Lister*

Jour. Bot. 48 : 312. 1910.

With the characters of the family. The one species was originally described by Lippert as a didymium on the basis of calcareous deposits in the sporangium wall. These have not been observed in numerous later collections. A distinctive genus, well regarded as the type of a separate family.

A single species:

COLLODERMA OCULATUM (*Lipp.*) *G. List.*

Jour. Bot. 48 : 312. 1919.

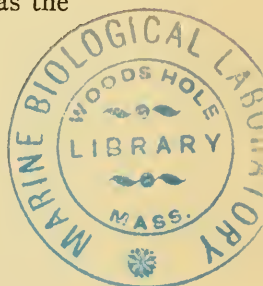
Pl. X, Figs. 220, 221, 222.

1894. *Didymium oculatum* Lipp., Verh. Zool.-Bot. Ges. Wien 44 : 72.

Sporangia gregarious, globose, subglobose or pulvinate, sessile or short-stipitate, olivaceous or brown, becoming black when old and dry, smooth and shining, the outer peridium gelatinous, thickened by moisture, hyaline; stipe, when present, thick, dark brown; columella none; capillitium resembling that of *Didymium*, purplish brown, colorless at the tips, often duplex, the darker interior portion surrounded by a hyaline sheath, the latter usually broken up into segments or fragmented; spores spinulose, fuscous, 11–13  $\mu$ .

Swollen by immersion in water the sporangia take on the eye-like appearance which suggested the specific name.

New Hampshire, Vermont, Oregon; Europe, Australia, Japan.



## FAMILY STEMONITACEÆ

Fructification æthalioid or of separate and distinct sporangia; capillitium usually abundant, typically in the form of dividing and anastomosing branches arising from all parts of the columella, the latter sometimes lacking or indistinct; hypothallus membranous, often common to a group of sporangia. The first two genera are of doubtful affinity with the others.

## KEY TO THE GENERA OF THE STEMONITACEÆ

- a. Stipe and columella calcareous, rarely waxy . . . . . 1. *Diachea*
- a. Wholly non-calcareous . . . . . b
  - b. Fructification æthalioid . . . . . c
  - b. Fructification sporangiate . . . . . e
- c. Capillitial threads unbranched, united into columnar cords and attached to both base and peridium; columella lacking . . . 2. *Schenella*
- c. Capillitium branched, dendroid . . . . . d
  - d. Columellæ obscure or lacking; capillitium not vesicular . . . 3. *Amaurochæta*
  - d. Columellæ distinct above, merging below; capillitium vesicular . . . . . 4. *Brefeldia*
- e. Tips of capillitial branches united to form a more or less complete surface net . . . . . 5. *Stemonitis*
- e. Surface net lacking, or scantily and imperfectly developed . . . 6. *Comatricha*

1. *Diachea* Fries

Syst. Orb. Veg. 1 : 143. 1825.

Sporangia distinct, globose or cylindric, usually stipitate; peridium thin, iridescent; stipe and columella charged with lime, white to orange, rigid, thick, tapering upward; capillitium of delicate threads free from lime, radiating from various points on the columella, branching and anastomosing as in *Comatricha* to form a more or less intricate network, the ultimate branchlets supporting the peridial wall.

Rostafinski placed this genus near the *Didymiæ* on account of the calcareous columella and the non-calcareous capillitium. On the other hand the structure of the capillitium and the iridescent simple peridium ally *Diachea* to *Lamproderma* and the *Stemonitaceæ*, the only distinction being the calcareous stem. It is simply an intermediate genus to be placed here more conveniently than anywhere else in what is of necessity a linear arrangement.

## KEY TO THE SPECIES OF DIACHEA

- a. Lime deposits white . . . . . b
- a. Lime deposits orange, or lacking . . . . . f
  - b. Sporangia typically cylindrical . . . . . 1. *D. leucopodia*
  - b. Sporangia ovate, globose or hemispherical . . . . . c

- c. Stalks equalling or exceeding height of sporangia. . . . . d  
 c. Stalks very short, sometimes lacking. . . . . e  
 d. Spores sparsely and irregularly warted. . . . . 2. *D. bulbilosa*  
 d. Spores with numerous dark warts and lines forming an im-  
   perfect reticulation. . . . . 3. *D. splendens*  
 e. Spores spinulose or warted. . . . . 4. *D. radiata*  
 e. Spores distinctly warted-reticulate. . . . . 5. *D. subsessilis*  
 f. Calcareous deposits orange or orange-yellow. . . . . 6. *D. thomasi*  
 f. Lime lacking; stem translucent, waxy or black, with wax  
   deposited as a collar at junction with sporangium. . . . . 7. *D. cerifera*

# 1. DIACHEA LEUCOPODIA (Bull.) Rost.

Mon. 190. 1875.

Pl. X, Figs. 226, 227, 228.

1791. *Trichia leucopodia* Bull., Champ. 121, Pl. 502, fig. 2.  
 1797. *Stemonitis elegans* Trentep. in Roth, Cat. Bot. 1 : 220.  
 1801. *Stemonitis leucostyla* Pers., Syn. Meth. Fung. 186.  
 1805. *Stemonitis leucopodia* DC., Fl. Fr. 2 : 257.  
 1825. *Diachea elegans* Fr., Syst. Orb. Veg. 143.  
 1892. *Diachea confusa* Massee, Mon. 259.

Sporangia rather closely gregarious, metallic blue or purple-iridescent, cylindric or ellipsoidal, obtuse, subumbilicate below, stipitate; stipe short, much less than one-half the total height, snow-white, tapering upward; hypothallus white, venulose, forming an open network over the substratum from which the sporangia arise; columella thick, cylindric, tapering, blunt, terminating below the apex, white; capillitium springing from every part of the columella, of slender threads, brown, flexuous, branching and anastomosing to form an intricate net; spores in mass nearly black, by transmitted light dull violaceous, minutely roughened, 8–11  $\mu$ .

A very beautiful species; common in the United States. Easily recognized, amid related forms, by its snow-white stem and cylindrical sporangium. Fries adopted the specific name proposed by Trentepohl and wrote *D. elegans*, simply because to him the peridium was "admodum elegans."

The peridium is exceedingly thin and early deciduous; the stipe long-persistent. The plasmodium, dull white, was observed by Fries at the beginning of the century; "morphoseos clavem inter myxogastres hoc genus primum mihi subministravit." Rostafinski wrote the specific name *leucopoda*, in which spelling he is followed by Massee and Lister. Bulliard wrote *leucopodia* and there seems to be no reason for changing the spelling.

This species, as the diacheas generally, affects fallen sticks and



leaves in orchards and forests and even spreads boldly over the foliage and stems of living plants.

Var. *globosa* Lister, with globose or subglobose sporangia, is connected with the typical form by continuous series. Apparently much less common and usually occurring with it. Distinguished from *D. bulbilosa* by the spores.

Cosmopolitan.

## 2. DIACHEA BULBILLOSA (*Berk. & Br.*) *List.*

Jour. Bot. 36 : 165. 1898.

Pl. X, Fig. 235.

1873. *Didymium bulbiliosum* Berk. & Br., Jour. Linn. Soc. 14 : 84.

1909. *Diachæella bulbilosa* Höhnelt, Sitzungsber. Akad. Wiss. Wien, Math.-Nat. Kl. (I) 118 : 437.

Sporangia gregarious, globose, stipitate, small, smooth, 0.3–0.4 mm. in diameter, and 1.5 mm. or less tall; stipe conical, white or sometimes brown; capillitium of purple-brown threads united to form a lax net; spores violet-gray, rather sparsely and irregularly warted, the warts dark and varying in size, 7–11  $\mu$ .

Said to be common in southern Asia. Specimens from Ontario, collected by Miss Currie and reported by her in the "Slime-molds of Ontario," show spores rather variable in size, mostly between 8.1 and 9.6  $\mu$ , and averaging about 9  $\mu$ , not 7.8  $\mu$  as she states. A collection of Morgan's from Ohio, labelled by him *Diachæa longipes* Morgan, with dark, sparsely warted spores, 7.5–8  $\mu$ , is also this species.

Ontario, Ohio; southern Asia.

## 3. DIACHEA SPLENDENS *Peck*

Rept. N. Y. State Mus. 30 : 50. 1878.

Pl. X, Figs. 229, 230.

1925. *Diachea bulbilosa* (Berk. & Br.) List. var. *splendens* G. List., Mycetozoa ed. 3. 103.

Sporangia gregarious, metallic blue with brilliant iridescence, globose, stipitate, 0.3–0.6 mm. in diameter, a millimeter or more tall; stalk conical, about equal to the diameter of the sporangium, tapering upward; hypothallus white, venulose, a network supporting the snowy stipes; columella white, cylindric, obtuse, passing the center; capillitium lax, of slender brown threads anastomosing to form a network; spores in mass black, by transmitted light pallid, with very coarse, dark warts and ridges forming an incomplete reticulation on the surface, 7–10  $\mu$ .

This is perhaps the most showy species of the list. The globose,

brilliantly iridescent sporangia are lifted above the substratum on snow-white columnar stalks; these are again joined one to another by the pure white vein-like cords of the reticulate hypothallus. The plasmodium may spread very widely over all sorts of objects that come in the way, dry forest leaves and sticks, or the fruit and foliage of living plants. Closely resembling *D. leucopodia*, but differing in the globose sporangia, it may be instantly recognized under the lens by its coarsely papillate and subreticulate spores.

Miss Lister regards this as a variety of *D. bulbillosa*. So far as our scanty material of the latter species enables us to judge, they are clearly distinct.

Not common. New York, Pennsylvania, Ontario, Ohio, Iowa, Nebraska.

#### 4. DIACHEA RADIATA *G. Lister & Petch*

Jour. Bot. 54 : 130. 1916.

Sporangia loosely clustered, or crowded in large colonies, hemispherical or globose, 0.4–0.5 mm. in diameter, sessile or rarely stalked, iridescent-gray or bronze, seated on a white hypothallus; sporangium wall membranous, colorless; stalks, when present, short, stout, furrowed, white, calcareous; columella white, convex, conical or short-cylindrical; capillitium a network of purple-brown threads radiating from the columella; spores pale violet-gray, spinulose or warty, 8–11  $\mu$ . Plasmodium orange-yellow.

Apparently close both to *D. subsessilis*, from which it is separated by spore characters, and to the globose phase of *D. leucopodia*, from which it would seem to differ in the color of the sporangium wall and that of the plasmodium. Specimens not seen.

Ceylon, southern Nigeria.

#### 5. DIACHEA SUBSESSILIS *Peck*

Rept. N. Y. State Mus. 31 : 41. 1879.

Pl. X, Figs. 231, 232.

Sporangia gregarious or closely crowded, small, about 0.5 mm., dull iridescent-blue or greenish gray, globose or depressed-globose; stipe generally very short, reduced sometimes to a mere persistent cone, white or pale brown; columella obsolescent or reduced to a conical intrusion of the stipe; capillitium radiating from the stipe, brown, consisting of branching, anastomosing threads, paler at the tips; hypo-

thallus very scanty or none; spores distinctly reticulate-warted, violet-brown, paler under the lens, 10–12  $\mu$ . Plasmodium yellow.

Somewhat resembling *D. splendens*, but duller in hue, more olivaceous, usually with a much shorter stalk and almost without columella. The spores are quite different, the network composed of lines of warts, but much more regular than in *splendens*.

According to Lister, *Lamproderma fuckelianum* Rost. is probably this species. Rostafinski's figure suggests that this may be so, but in view of the uncertainty, Peck's name is retained.

Rare. Connecticut, New York, Iowa, Colorado; Europe, Java, Ceylon.

#### 6. DIACHEA THOMASII *Rex*

Proc. Acad. Nat. Sc. Phila. 1892 : 329.

Pl. X, Figs. 233, 234.

Sporangia gregarious, more or less crowded, purple and bronze, iridescent, globose, sessile or short-stipitate; stipe, when present, very short, thick, tapering rapidly upward, orange; hypothallus orange, prominently venulose, continuous; columella ochre yellow, rough, cylindric or conical, tapering upward to one-half the height of the sporangium, obtuse; capillitium lax, of slender brown rigid threads, radiating from the columella in every direction, anastomosing to form a loose, large-meshed network; spore-mass brown; spores by transmitted light violaceous, minutely, unevenly warted, 11–13  $\mu$ .

The peculiar orange color of the calcareous deposits in stipe and columella easily distinguishes this species. The capillitium is also distinctive, rigid, simple and comparatively scant, lamprodermoid. *Rex* calls attention to the fact that under low magnification the spores appear spotted; but the spots are occasioned simply by the closer aggregation, at particular points, of the ordinary papillæ.

A southern species. Mountains of North Carolina and Tennessee.

#### 7. DIACHEA CERIFERA *G. List.*

Jour. Bot. 51 : 3. 1913.

Pl. X, Fig. 236.

1911. *Lamproderma columbinum* (Pers.) Rost. var. *sessile* Lister, Mycetozaa ed. 2. 165.

Sporangia scattered or in small clusters, limeless, stalked, subglobose or ovoid, 0.7–1.2 mm. in diameter, shining iridescent brownish purple; sporangium wall membranous, hyaline, often yellowish and persistent below; stalk brownish black, yellowish brown or white, 0.2–0.6 mm.

tall, sometimes with a thick yellow waxy collar at apex just below the sporangium; columella none, but the base of the sporangium broad and flat, the capillitium of rigid, sparsely branched and anastomosing purple filaments arising from this in brush-like fashion; spores purplish gray, spinulose, 10–18  $\mu$  in diameter. Plasmodium white.

Scarcely a diachea as here defined; suggesting *Lamproderma*, but without a columella. The spore range as given by Miss Lister seems unduly great. Specimens from Switzerland have spores 11–13  $\mu$ , rather sparsely spinulose, and waxy stems, although lacking the collar. It seems possible that Miss Lister's genus *Leptoderma* might be so emended as to accommodate this distinctive species, but pending further study it may remain here.

Europe, Japan.

## 2. *Schenella Macbride*

Mycologia 3 : 39. 1911.

Fructification æthalioid, depressed, flat, covered by a fragile, continuous crust; capillitium of simple threads twisted together to form vertical, closely arranged columns passing from the base to the outer peridium as if supporting it. Spores fuscous black.

A single species:

### SCHENELLA SIMPLEX *Macbride*

Mycologia 3 : 39. 1911.

Pl. X, Figs. 237, 238; Pl. XXI, Figs. 563, 564.

Æthaliium oval, about 4 cm. long by 2 cm. wide and 3 mm. thick; peridium pallid, soon disappearing; capillitium abundant, dark brown, exposed by the breaking up of the crust-like peridium and then having the appearance of a stemonitis colony, each column being made up of a number of tubular, smooth, unsegmented threads twisted together so as to form a cord, and in some instances covered in whole or part by a delicate common sheath; spores very dark, spherical, ovate or sometimes pyriform, rather coarsely tuberculate, when spherical 5–6  $\mu$  in diameter.

A very curious form, of somewhat doubtful affinities and placed in the Stemonitaceæ on the basis of the dark violet-brown spores and the dark capillitium. There is no suggestion of columellæ in the pillar-like columns. To the naked eye it suggests an amaurochæte. In addition to the typical spores, there occur in every mount a few paler, larger,



minutely echinulate spores, 8–9  $\mu$  in diameter, whose origin is not apparent.

Type collected in the Yosemite valley, California, August, 1903, by T. H. Macbride. Known only from the type collection.

### 3. *Amaurochæte* Rost.

Versuch 8. 1873.

Fructification æthalioid, pulvinate; peridium evanescent, leaving after its disappearance a mass of irregular stalks and branches, forming the capillitium complex, seated on a common, dark, membranous hypothallus. Capillitium and spores usually black or dark brown in mass, rarely ferruginous.

In *Amaurochæte* the individuality of anything like separate sporangia is not clear. The view afforded, however, by a good vertical section of a well-developed colony or cushion is interestingly arborescent. Ragged, dendroid stems arise, dissipated above into an intricate network. The resemblance of the overhead net to that presented by a stemonitis or comatricha is very striking.

#### KEY TO THE SPECIES OF AMAUROCHÆTE

- |  |                          |
|--|--------------------------|
| a. Capillitium rigid, irregular . . . . .  | b                        |
| a. Capillitium soft, woolly, circinate . . . . .   | d                        |
| b. Capillitium and spores brown in mass; spores 7.5–9 $\mu$ , pale . . . . .                                       | 1. <i>A. ferruginea</i>  |
| b. Capillitium and spores black in mass; spores 12.5–15 $\mu$ . . . . .  | c                        |
| c. Spores spinulose . . . . .  | 2. <i>A. fuliginosa</i>  |
| c. Spores strongly reticulate . . . . .  | 3. <i>A. trechispora</i> |
| d. Capillitium composed of numerous stout, often columella-like branches, giving rise to a dense network . . . . . | 4. <i>A. tubulina</i>    |
| d. Capillitium composed almost wholly of slender flexuose threads . . . . .  | 5. <i>A. comata</i>      |

#### 1. *AMAUROCHÆTE* FERRUGINEA Macbride & Martin

Jour. Wash. Acad. Sc. 22 : 89. 1932.

Pl. XI, Fig. 241.

Æthaliium pulvinate, flat, up to 7 cm. in length and 4 cm. in width; peridium fugacious; hypothallus shining, silvery, extending somewhat beyond the margin of the æthaliium; definite columellæ lacking, but capillitium branching from numerous rigid irregular branches arising from the hypothallus and soon dissipated into subordinate branches, the threads dark brown, bearing numerous lighter brown irregular membranous expansions; spores cinnamon-drab to benzo-brown

(Ridgway) in mass, pale reddish brown by transmitted light, minutely warted, 7.5–9  $\mu$ .

The structure of the capillitium is very similar to that of *A. fuliginosa*, from which species this differs in the brownish color of the capillitium and in the small, pale, relatively smooth, ferruginous spores, the two characters together giving the fructification a ferruginous cast in marked contrast to the black of the other species of the genus.

California, Oregon.

## 2. AMAUROCHÆTE FULIGINOSA (Sow.) Macbr.

N. A. Slime-Moulds 109. 1899.

Pl. XI, Fig. 242.

- 1803. *Lycoperdon fuliginosum* Sowerby, Engl. Fungi 257.
- 1805. *Lycogala atrum* Alb. & Schw., Consp. Fung. 83.
- 1815. *Strongylium atrum* (Alb. & Schw.) Swartz, Hand. K. Svenska Vet. Acad. 110.
- 1817. *Strongylium majus* Fr., Symb. Gast. 9.
- 1822. *Reticularia strongylium* Schw., Schrift. Nat. Ges. Leipz. 1 : 35.
- 1829. *Reticularia atra* (Alb. & Schw.) Fr., Syst. Myc. 3 : 86.
- 1875. *Amaurochæte atra* (Alb. & Schw.) Rost., Mon. 211.

Æthalia varying in form and size, if on the upper side of the substratum, pulvinate, if below, pendent and almost stipitate, covered with a delicate cortex, at first shining, soon dull, black, fragile and early dissipated; hypothallus long-persisting, supporting the capillitium, which is extremely variable, irregular and for its perfection dependent upon the form assumed by the æthaliium, and the conditions under which it matures; sometimes, especially when prostrate in a very much depressed æthaliium, spreading into long fibrous threads, again, under better conditions, rising in columella-like forms, supporting a peripheral net; spores dark brown or black, irregularly globose, spinulose, 12.5–15  $\mu$ .

Sowerby, in his comment on pl. 257, Eng. Fungi, says: "It appears to consist of branching threads affixed to the deal and holding a dense mass of sooty powder. Over the whole is a thin, deciduous pellicle." This description seems to be applicable to nothing else. The figure amounts to little. Fries recognizes the English description, as does Rostafinski, but both authors adopt the later name given by Albertini and Schweinitz, simply because of the excellent detailed description found in the *Conspectus*.

Common in Europe, and probably not uncommon in this country wherever pine forests occur; also in Japan. Specimens before us are from New England and New York, Ohio, Carolina, Colorado and Canada.

3. AMAUROCHÆTE TRECHISPORA *Macbride & Martin*

Jour. Wash. Acad. Sc. 22 : 89. 1932.

Pl. XI, Figs. 239, 240.

Æthelium pulvinate, flat, up to 7 cm. in length; cortex dark, shining, evanescent, faintly tuberculate as though suggesting the tips of component sporangia; hypothallus broadly expanded, persistent, extending well beyond the borders of the æthelium, silvery, with yellowish stains and amber globules representing remnants of the presumably yellow plasmodium; capillitium black, irregular, composed of numerous stout columella-like bases which soon become dissipated into numerous branches, these anastomosing freely; peripheral nets lacking; spores purplish black in mass, lilaceous brown by transmitted light, globose, ornamented with a pronounced reticulation formed of wing-like ridges, the meshes coarse and often unequal, 13–15  $\mu$  in diameter, of which 10–12  $\mu$  represents the diameter of the body of the spore, the balance the ridges of the reticulum.

A well-marked species, related to *A. fuliginosa* but separated by its remarkable and striking spores. Based on a collection from northern Ontario well described by Miss Currie and by her doubtfully referred to *Stemonitis fusca* Roth. var. *trechispora* Torrend. A later collection from the same region by Dr. Jackson confirms the species. Aside from the reference to the strongly reticulated spores and the occurrence on Sphagnum, there is nothing in Torrend's brief description of his variety to suggest the present species, nor can it be the form described and illustrated by Jahn as *Stemonitis trechispora* Torr. It is clearly an Amaurochæte.

Ontario.

4. AMAUROCHÆTE TUBULINA (*Alb. & Schw.*) *Macbr.*

N. A. Slime-Moulds ed. 2. 150. 1922.

Pl. XI, Fig. 243.

1805. *Stemonitis tubulina* Alb. & Schw., Consp. Fung. 102.1825. *Lachnobolus cribrosus* Fr., Syst. Orb. Veg. 148.1917. *Amaurochæte cribrosa* (Fr.) Sturgis, Mycologia 9 : 328.1924. *Matruchotiella splendida* Skup., Bull. Acad. Pol. Sc. 396.

Plasmodium at first transparent, then white, then rosy, ashen or gray, finally deepening to jet-black; the æthelium even, thin, variable in extent from one to ten centimeters, covered by a distinct but thin transparent cortex, papillate, extended laterally but a short distance beyond the fructification, fragile, soon disappearing; hypothallus long-persistent, thin, silvery, supporting the capillitium as if by stipes, short slender columns, irregular plates, expansions, etc.; capillitium

an intricate network, very abundant, elastic, on fall of the peridium appearing like tiny tufts of wool, the meshes large, but formed as in *Stemonitis*, persistent, dull black; spores, under the lens, dull olivaceous black, minutely roughened, 12-14  $\mu$ .

This species differs from *A. fuliginosa* especially in the capillitial characters. In the latter species the capillitial branches fray out, and are only sparingly united into an extremely lax net. In the present form the net is the thing common to the entire fructification. The total effect is to lend to the blown-out æthallium a woolly appearance, entirely unlike that of its congener under the same conditions. But until fructification is quite mature, the presence of component sporangia below is suggested by the papillose upper surface, and even after maturity the suggestion of sporangia persists when viewed with a hand lens.

The amaurochætæ are remarkable in that they appear upon coniferous wood, logs or lumber, to all appearance undecayed. The species just described developed abundantly in August on the recently decorticated logs of *Pinus ponderosa*, on the southwestern slopes of Mt. Rainier, Washington. In logging operations in the locality referred to, the trees are felled often at a considerable distance from the mill. The logs are dragged along the ground, the transportation facilitated by removal of the bark from the new fallen trunk. In a few weeks' time, affected by alternate rain and sun, the whole surface becomes marked with hundreds of minute, almost invisible cracks, and it is in the larger of these that the plasmodium of the present species has its habitat. The plasmodia rise to fructification, scores at a time, upon a surface, new and white, showing otherwise no evidence of any decomposition. Doubtless the persisting cambium, the unused starches, sugars, the wood of the season yet unlightened, afford easily accessible nutrition.

When this form was first examined in the laboratory its distinctness was immediately seen. It was without doubt Fries' *Lachnobolus cribrusus*. Under this name, citing Fries' description, specimens were sent out to various herbaria. Further study of the records, however, soon convinces one that we are here face to face with the species described by Albertini and Schweinitz in their fine "Conspectus." Their account of the form, evidently often taken and now described with great care, is entirely clear when read in the presence of the facts. The matter is discussed fully in North American Slime-Moulds, 2 ed., pp. 151 ff.

Zukal (Verh. Zool.-Bot. Ges. Wien 35 : 335) describes *A. speciosa* as a new species. This Saccardo writes down (Syll. Fung. 7 : 399)



*S. tubulina* Alb. & Schw., admitting, however, at the same time, that as fine an authority as Raciborsky refuses to call Zukal's species either a stemonite or an amaurochæte, thinking it deserving of generic appellation of its own. However, *A. speciosa* Zuk. need not here concern us. Neither in his description nor figures does Zukal at all approach the form we study. His species is not an amaurochæte; the size of the spores suggests that, to say nothing of the capillitial structure.

In the same volume Saccardo introduces another amaurochæte, *A. minor* Sacc. & Ellis (Mich. 2 : 566). This is American, sent from Utah by our famous pioneer collector Harkness. A portion of this collection is in the herbarium of the University of Iowa, and is by us referred to *Lepidoderma granuliferum*.

Massachusetts, Pennsylvania, Washington; Europe.

#### 5. AMAUROCHÆTE COMATA G. List. & Brandza

Jour. Bot. 64 : 225. 1926.

Æthalia scattered, pulvinate, black and glossy, 5–50 mm. in diameter, on a shining membranous hypothallus; columellæ none; capillitium of flexuose, branching, black threads, 1–3  $\mu$  in diameter, attached above and below to the membranous walls of the æthaliium; spores 11–14  $\mu$  in diameter, dark purplish gray, closely warted, somewhat paler and smoother on one side. Plasmodium white.

In general appearance closely resembling *A. tubulina*, but differing in the absence of any suggestion of columellæ, in the finer and more flexuose capillitium and in the darker, more distinctly warted spores. The original description gives the spore-size as 11–12  $\mu$ . Spores of authentic material from Professor Brandza average 13.2  $\mu$  and range from 11–14  $\mu$ , occasionally varying beyond these limits.

Rumania, Switzerland.

#### 4. Brefeldia Rostafinski

Versuch 8. 1873.

Fructification æthalioid, the constituent veins occupying several layers, those of the median, and especially of the lowest layer furnished with columellæ which blend beneath; capillitium threads arising from the columellæ and united at adjacent tips by prominent inflated sacs.

The genus *Brefeldia* is, like some others, difficult to dispose of in any scheme of classification where linear sequence must be followed. Rostafinski placed it in an order by itself. Its relationships are on the one hand with *Amaurochæte* and on the other with *Stemonitis*, though it is easily distinguished from either of these genera. It is intermediate between the two, but apparently a little nearer *Stemonitis*.

## BREFELDIA MAXIMA (Fr.) Rost.

Versuch 9. 1873.  
Pl. XI, Figs. 244, 245.

1825. *Reticularia maxima* Fr., Syst. Orb. Veg. 1 : 147.

1848. *Licea perreptans* Berk., Gard. Chron. 451.

*Æthaliium* large, four to twenty cm. across, papillate above, violet-black at first, then purple or purple-brown, developed upon a wide-spread, silver-shining hypothallus, the peridium at first papillate, early fugacious, the capillitial branches often falling off with the spores, leaving the black columellæ rising nearly naked from the base; capillitium abundant, the threads uniting by multifid ends to surround as with a net the peculiar vesicles; spore-mass dark violet-black or fuscous, the individual spores paler by transmitted light, distinctly papillose, 9–12  $\mu$ .

A very remarkable species and one of the largest, rivalled only by *Fuligo*. To be compared with *Reticularia*, which it resembles somewhat externally, and with some of the larger specimens of *Enteridium*. The plasmodium, at first white with a bluish tinge, is developed abundantly in rotten wood, preferably a large oak stump, and changes color as maturity comes on, much in the fashion of *Stemonitis splendens*, leaving a widespread hypothallic film to extend far around the perfected fruit-mass. In well-matured *æthalia* the sporangium-like units stand out distinctly, particularly above and around the margins. Closely and compactly crowded, they become prismatic by mutual pressure, and attain sometimes the height of a centimeter or more. In the center of the fructification, next the hypothallus, these structures are very imperfectly differentiated. Many are here horizontally placed, and perhaps supplied with an imperfectly formed peridium,—if so may be interpreted the lowest parts of the capillitial structure, the long, branching, ribbon-like strands which lie along the hypothallus. Some of these branch repeatedly with flat anastomosing branchlets, ultimately fraying out into lengthened threads, and remain after the superstructure has been blown away. From every part of the structure so described, but more especially from the margins, are given off in profusion the strange cystiferous threads, so characteristic of this genus. These are exceedingly delicate filaments, attached at one end, it may be, to a principal branch, at the other free or united to a second which again joins a third, and so looping and branching they form a more or less extended network, a capillitium in which are entangled the myriad spores. Each filament bears at its middle point (or is it the meeting-point of two?) a peculiar plexus

which embraces several large cysts or vesicles whose function or homology is not clear.

From the base of the fructification rise also ascending branches which are black, terete and not infrequently branched as if to form the capillitium of a stemonitis. These ascending branches are in many cases, probably in all, real, though as yet imperfectly developed, columellæ. They rise, at least in many cases, directly from the hypothallus; each is central to one of the individual units referred to, rising to about two-thirds its height, but never attaining the summit. The columella bears cystiferous threads sparingly, if at all; nevertheless these abound in the intermediate portions of the capillitium, and are especially noticeable beyond the level of the top of the columella. Many are so arranged that the plexus with its vesicles occupies a place in the plane separating adjacent units, suggesting the possibility that we have here to do with an imperfectly developed surface net and peridium. In this view the cysts would represent the meeting-point of two opposite radial capillitial threads rather than the middle of one. This accords with Rostafinski's observations and drawings. The cysts, then, belong morphologically to the peridium or sporangium wall. It is a stemonitis whose sporangia have never been perfectly differentiated, a case of arrested development. See further under *Stemonitis confluens*.

*Dermodium inquinans* Lk. ex Fr., Symb. Gast. 9, 1817, is cited by Rostafinski as a probable synonym of this species, and distinct from the species so named by Link, which is thought to be a synonym for *Amaurochate fuliginosa*. Fries spells the generic name "Demordium." Rostafinski really offers the first definitive description. Fries probably distinguished it, but his description would not indicate the fact except for the added note wherein appears the reason for discarding an apparently older name given by Link. But neither Link nor Sowerby distinguished by description or figure *Brefeldia* from *Amaurochate*.

Throughout the northern forest, Maine to Vancouver Island, not common, Argentina; also throughout Europe.

### 5. *Stemonitis Gleditsch* emend. Rost.

Versuch 7. 1873.

1753. *Stemonitis* Gleditsch, Meth. Fung. 140, in part.

Sporangia distinct, though often closely aggregated, cylindric, stipitate; columella prominent; capillitium well developed by repeated lateral and apical branching of the columella, at length assuming at

the surface the form of a distinct net which supports an evanescent peridium.

The genus is marked by its surface net supported at the tips of the dichotomously branched divisions of the columella. Over the net is spread, theoretically at least, the peridial film supported at times by very short points projecting from the net—the peridial processes; the peridium, however, is seldom seen; in some cases perhaps never developed. Rostafinski first defined the genus as employed by recent writers. Gleditsch simply renamed Micheli's *Clathroidastrum*; all writers up to the time of Rostafinski included species of other genera.

The taxonomy of this genus is extremely difficult. Macroscopic, defining characters are few, and even these sometimes uncertain. Microscopic distinctions also tend to be illusive, variable in such fashion that often at the critical point the most exact description fails. All that may be done at present is to recognize two or three definite types and then cautiously differentiate among these until more general study of the group brings to service a wider range of observation.

Since spore characters seem to be reasonably constant, they are largely stressed in the accompanying key. The surface is in some species beautifully and plainly reticulate, in others, the reticulations, while present, are very delicate, and an oil immersion lens is required to distinguish them. In some species, notably *S. fusca*, the reticulations are combined with warts at the angles. These are referred to as verrucose-reticulate. Some are rather coarsely papillate, others nearly smooth even under oil. The capillitium is more variable but is often distinctive.

## KEY TO THE SPECIES OF STEMONITIS

- |   |                           |
|---|---------------------------|
| a. Spores reticulate or verrucose-reticulate.....   | b                         |
| a. Spores not reticulate; verrucose to smooth.....  | f                         |
| b. Sporangia connate below.....   | 1. <i>S. trechispora</i>  |
| b. Sporangia distinct, appressed or scattered.....  | c                         |
| c. Spore-mass black; net developed mainly at base; 3–6 mm. tall.....  | 2. <i>S. nigrescens</i>   |
| c. Spore-mass fuscous or paler.....   | d                         |
| d. Dark fuscous; surface net rather coarse; 18–25 mm. tall.....   | 3. <i>S. dictyospora</i>  |
| d. Fuscous; surface net fine-meshed; usually 6–10 mm. tall.....   | 4. <i>S. fusca</i>        |
| d. Paler, with vinaceous tints, in small clusters; usually under 6 mm. tall.....                                | e                         |
| e. Benzo-brown; spores banded-reticulate; surface net often incomplete.....                                     | 5. <i>S. virginiensis</i> |
| e. Lilaceous brown; spores faintly and irregularly reticulate; surface net developed below only.....            | 6. <i>S. hyperopta</i>    |
| f. Sporangia connate with plate-like processes at junctions of capillitial branches of adjoining sporangia..... | 7. <i>S. confluens</i>    |
| f. Sporangia separate.....  | g                         |



- g. Spores in clusters of 4 or more. . . . . 8. *S. uvifera*
- g. Spores not in clusters. . . . . h
- h. Sporangia over 15 mm. tall, flexuous. . . . . i
- h. Sporangia under 15 mm. tall, subflexuous to erect. . . . . j
- i. Sporangia angular in section; columella more or less lateral 9. *S. fenestrata*
- i. Sporangia terete; columella central. . . . . 10. *S. splendens*
- j. Peridial net with coarse meshes, 50–125  $\mu$  across. . . . . 11. *S. webberi*
- j. Meshes of peridial net mostly less than 50  $\mu$ . . . . . k
- k. Spores under 7  $\mu$  in diameter, nearly smooth. . . . . l
- k. Spores 7  $\mu$  in diameter or larger, verrucose. . . . . m
- l. Sporangia 7–15 mm. tall; ferruginous; spores 5–7  $\mu$ . . . . . 12. *S. axifera*
- l. Sporangia under 5 mm. tall; vinaceous; spores 4–5  $\mu$ . . . . . 13. *S. smithii*
- m. Purplish ferruginous; closely fasciculate; columella often with plate-like expansions at tip. . . . . 14. *S. flavogenita*
- m. Sporangia in small, scattered clusters or gregarious; columella without plate-like expansions. . . . . n
- n. Slender, acuminate; columella dissipated below tip of sporangium; 7–10 mm. tall. . . . . 15. *S. carolinensis*
- n. Columella ending abruptly below obtuse tip of sporangium, 3–7 mm. tall. . . . . o
- o. Peridial net close-meshed, scantily developed above; usually on wood. . . . . 16. *S. pallida*
- o. Peridial net very fine, complete; usually on herbaceous stems or leaves. . . . . 17. *S. herbatica*

#### 1. STEMONITIS TRECHISPORA Macbr.

N. A. Slime-Moulds ed. 2. 159. 1922.

1909. *Stemonitis fusca* Roth, var. *trechispora* Torrend, Fl. Myx. 141.

Sporangia irregular, small, fuscous black \* to dull black, sessile or nearly so, and more or less coalescent below, free above, 5–7 mm. tall; columella black, tapering gradually to a point beneath the apex and giving rise to a capillitium of few, irregular branches; peridial net open, the meshes uniform in size, several times the spore-diameter; hypothallus continuous, well developed; spores nearly black in mass, purple-brown by transmitted light, strongly but irregularly reticulate with 20–30 or more meshes to the hemisphere, 10–12  $\mu$  in diameter. Plasmodium unknown.

*Stemonitis trechispora* was originally named by Berkeley but this name seems not to have been published (see Lister, ed. 3. 133). It is usually entered as a variety of *S. fusca*, but the very large, reticulate spores seem to be distinctive, and the color and structure are also distinct. A very abundant collection by Mr. Hagelstein, from Long Island, approaches *fusca* in its separate sporangia, but otherwise seems to belong here. Pending further information it seems best to maintain the species.

On vegetable debris, Maine, Long Island, Washington, Venezuela.

Reported from England, Denmark, Rumania and other European localities, also Malay Peninsula, Japan.

## 2. STEMONITIS NIGRESCENS *Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 392.

Pl. XI, Fig. 246.

1909. *Stemonitis fusca* Roth, var. *nigrescens* Rex ex Torrend, Fl. Myx. 141.

Sporangia gregarious in small, loose clusters upon a common hypothallus, erect, cylindric, stipitate, 3–5 mm. tall, fuscous black \* becoming fuscous when blown; stem black, extremely short, about 0.5 mm.; columella reaching the apex, violet-black, darker near the surface; peridial net developed chiefly at the base, elsewhere incomplete or lacking; spores black in mass, violet-brown by transmitted light, verrucose-reticulate as in *S. fusca*, but with reticulations less marked, 8–9  $\mu$  in diameter.

The author of this species remarks: "This species is noteworthy for its comparatively short stipes, its very spinulose spores, and its black or nearly black color, the slight violet tint being only apparent on close inspection, especially in fresh moist specimens."

It is a small but very beautiful form, at first sight to be mistaken for a short *S. fusca*, though much more intensely black before the spores are shed. The capillitium is concolorous, the inner network of rather few open meshes, the outer of large hexagonal openings, the arcuate threads of which are remarkable for the size, and especially the number, of the peridial processes, as many as five or six sometimes appearing along one side of a single mesh. The stipe is very short, and the columella runs as a straight, gradually diminishing axis to the very apex of the sporangium. Total height 3–5 mm.

Lister follows Torrend in regarding this as a variety of *S. fusca* but it seems distinct in size, habit and color.

Not common. Pennsylvania, Virginia, North Carolina, Indiana, Iowa, Arizona, Oregon, California; Wales.

## 3. STEMONITIS DICTYOSPORA *Rost.*

Mon. 195. 1875.

Pl. XI, Figs. 247, 248.

1893. *Stemonitis castillensis* Macbr., Bull. Nat. Hist. S. U. Iowa 2 : 381.

Sporangia slender, rigid, erect, 18–25 mm. tall, in large clusters, 4–8 cm. across, dark fuscous; columella prominent, reaching nearly to the apex, abundantly branched, the branches forming an intricate dark

capillitium; surface net large-meshed, the meshes several times the diameter of the spores; spores clear violet, strongly reticulate, 7–8  $\mu$ .

Obviously close to *S. fusca*, but distinguished by its unusual size, somewhat darker color, more robust capillitium, larger meshes of the net and more strongly reticulate spores.

A specimen sent by Massee to Wingate, said to have been named by Rostafinski, is certainly *S. fusca*, thus bearing out the comment in the Lister monograph. If *S. dictyospora* Rost. is not applicable to our large specimens they must some day be given a new name.

Collections from Moldavia, reported by Brandza (1929) as *S. fusca* and described as 2 cm. in height, may well belong here.

Oregon, Nicaragua; Europe.

#### 4. STEMONITIS FUSCA Roth

Roem. Mag. Bot. 2 : 26. 1787.

Pl. XI, Figs. 249, 250.

1792. *Trichia nuda* With., Br. Pl. ed. 2. 3 : 477.

1796. *Stemonitis fasciculata* Pers., Obs. Myc. 56, non 1791.

Sporangia slender, cylindrical, occurring in tufts, usually 6–8 mm. tall, occasionally larger; fuscous\* varying occasionally to benzo-brown\* or hair-brown\* and tending to become pallid as the spores are disseminated; stem black, shining, usually about one-fourth the total height but varying to one-half; columella prominent, mostly attaining the apex, branching freely; capillitium of slender dusky threads which anastomose freely to form a dense interior network; peridial net close-meshed; hypothallus scanty but distinct, membranous, common to all sporangia of a cluster; spores fuscous\* in mass, pale violet by transmitted light, covered with blunt spines or warts connected by delicate reticulate ridges, 7.5–10  $\mu$  in diameter. Plasmodium white, passing through blue to black.

The English monograph recognizes no less than five varieties in addition to the typical form. Of these five, *nigrescens* and *trechispora* are here regarded as distinct species; *rufescens* List. has verrucose-reticulate spores 5–8  $\mu$ ; *flaccida* List. has weak sporangia with imperfect surface net, and *confluens* List. is described as approaching *Amaurochaete*.

As here defined, the spores, the characteristic color, the moderate size and the typical growth habit are the distinctive features of the species. The spores possess blunt spines connected by reticulations which may be resolved into lines of minute warts. Forms with faintly spinulose or nearly smooth spores are excluded.

On rotten wood and occasionally on other substrata. Widely dis-

tributed in north temperate and tropical regions to Brazil and South Africa.

#### 5. STEMONITIS VIRGINIENSIS *Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 391.

Pl. XI, Figs. 251, 252.

Sporangia cylindric or elongate-ovate, gregarious in small clusters, benzo-brown \* to drab \*, 1.5 to 6 mm. tall, sometimes more; stem black, shining, 0.5–2 mm.; columella reaching apex, giving rise to a delicate capillitium; meshes of peridial net small, scarcely greater than diameter of spores; hypothallus common to the cluster; spores umber-brown in mass, pale lilac-brown by transmitted light, finely banded-reticulate, the reticulation often incomplete, 6–8  $\mu$  in diameter. Plasmodium unknown.

Distinguished from *S. fusca* by the small, slender, acuminate, vinaceous sporangia growing erect in small tufts and by the slightly smaller and banded spores.

On dead wood: Virginia, Iowa, Oregon, California; central and southwestern Europe.

#### 6. STEMONITIS HYPEROPTA *Meylan*

Bull. Soc. Vaud. Sc. Nat. 52 : 97. 1918.

Pl. XI, Figs. 253, 254.

1893. *Comatricha typhina* (Pers.) Rost. var. *heterospora* Rex, Proc. Ac. Nat. Sc. Phila. 367.

Sporangia in small, loose clusters, broadly cylindrical or somewhat ovate, lilaceous brown, 2–3.5 mm. tall; stalk short, continued into the slender columella; capillitium a close network of rather fine threads, coalescing to form a delicate surface net over the lower half or two-thirds of the sporangial surface; spores pale lilaceous, the surface covered by a faint, irregular reticulation with a few scattered warts, 5–6  $\mu$ . Plasmodium watery white.

The English monograph includes here as var. *microspora* Lister a form with spores 3.5–4  $\mu$ , synonymous with *Comatricha typhoides* var. *microspora* Lister 1894, and *C. microspora* Lister 1919.

The reticulations are exceedingly delicate, scarcely to be distinguished without the aid of an oil immersion objective.

The species is not commonly found in collections, but is probably not uncommon, probably ordinarily determined as *C. typhoides*, of



which Rex regarded it as a variety. The constant, even though usually incomplete surface net seems to warrant its place in *Stemonitis*. Material distributed by Morgan as *Comatricha pumila* (apparently not published) clearly belongs here.

Eastern United States, Washington, Puerto Rico, Chile; Europe, Japan.

7. *STEMONITIS CONFLUENS* Cooke & Ellis

Grev. 5 : 51. 1876.  
Pl. XI, Figs. 255, 256.

1894. *Stemonitis splendens* Rost. var. *confluens* Lister, Mycet. 112.

Sporangia fasciculate, dark fuscous, in close-set tufts on a persistent hypothallus; sporangia separated at tips and usually at bases, elsewhere confluent; total height 2–3 mm.; stipe short, sometimes indistinct or wanting, merging into the dark columella which in turn gives rise to a prolific membranously-angled capillitium, merging at boundaries into a large-meshed surface net; peridium fugacious, except where capillitial branches of neighboring sporangia are joined, where it persists as a disk-shaped membrane about equal to a surface mesh; spores blackish in mass, purplish brown by transmitted light, minutely spinulose, 12–14  $\mu$  in diameter. Plasmodium white.

Represented in the S. U. I. herbarium only by specimens collected by Ellis in New Jersey. In the Lister monograph the species is reported from New England and North Carolina, as well as from the British Isles, France and Germany. The description as there given makes it doubtful whether the species so reported is the same as our material. Meylan reports it from the Alps.

8. *STEMONITIS UVIFERA* Macbr.

N. A. Slime-Moulds ed. 2. 161. 1922.  
Pl. XI, Figs. 257, 258, 259.

Sporangia slender, cylindrical, tufted in medium sized clusters as in *S. fusca*, the individual sporangia more or less recumbent, fuscous\*, 7–9 mm. high; stipe black, polished, one-fourth to one-third the total height; columella not reaching sporangial tip, marked by obscure spirals; capillitium of stout branches, often membranously flattened at angles; peridial net with large irregular meshes and many free ends; hypothallus distinct, common to all sporangia; spores nearly black in mass, pale sooty brown by transmitted light, somewhat flattened and often irregular in shape, distinctly verruculose over three-fourths of the

surface, the rest smooth, mostly 8–10  $\mu$  in diameter, but many larger, clustered in groups of four or more, rarely single.

The clustered spores and the loose surface net are the outstanding characteristics of this species. Miss Lister speaks of a cap of minute spines on the exposed side of the spores. This is scarcely adequate, as the illustrations will show.

Rare. District of Columbia, Pennsylvania, Montana, Washington.

#### 9. *STEMONITIS FENESTRATA* Macbr.

N. A. Slime-Moulds ed. 2. 166. 1922.

Pl. XI, Figs. 260, 261.

1890. *Stemonitis bauerlinii* Mass. f. *fenestrata* Rex, Proc. Ac. Nat. Sc. Phila. 1890 : 37.

Sporangia aggregated, in tufts 2 cm. or more in diameter, rich purple-brown, on a common hypothallus, more or less erect, stipitate, 15–22 mm. tall, slender, triangular in section; stipe black, about one-third the total height, passing into a slender columella which is lateral in position, not central, but little branched, continued almost to the apex; the capillitium consisting almost entirely of the peripheral net, which presents meshes of unusual uniformity of size and shape; spores dark in mass, pale brownish by transmitted light, spherical or slightly elongated, 7–8.5  $\mu$ . Plasmodium probably white.

The remarkable shape of the sporangium and the peculiar regularity of the surface net, the lateral columella, all combine here to warrant the erection of a distinct species. Doctor Rex referred this to *S. bauerlinii* Mass. At that time he had not the author's description, and had seen only a very poor fragment received with notes in a letter. Mr. Masee's description makes it immediately evident that whatever other affiliations *S. bauerlinii* may have, by description it has at least none with *S. fenestrata*. Masee's species is described as having the "mass of spores black," the capillitium with branches springing from the columella, the main branches more and more numerous, thicker, and irregular towards the apex of the sporangium, and often forming irregular, flattened expansions. This suggests some form of *S. dictyospora* Rost. Possibly for such reasons Lister referred it to *S. splendens* Rost., which was undoubtedly regarded by the author as belonging to the *fusca* group.

The long, slender, simple columella is not only lateral, but occupies the sharp vertical angle of the triangular, prismatic sporangium. Furthermore, the sporangium is at maturity strangely twisted, so that the columella in its ascent accomplishes one or more spiral turns. In forms collected by Dr. Rex, which seemed to him most nearly to

agree with Masee's species, the inner capillitium is somewhat abundant, but the character of the columella just the same.

On rotten wood, eastern United States and Ontario to Colorado; India.

#### 10. *STEMONITIS SPLENDENS* Rost.

Mon. 195. 1875.

Pl. XI, Figs. 262, 263.

1880. *Stemonitis morgani* Peck, Bot. Gazette 5 : 33.

1892. *Stemonitis maxima* Schw. ex Masee, Mon. 74.

1892. *Stemonitis acuminata* Mass., Mon. 78.

1892. *Stemonitis bauerlinii* Mass., Mon. 79.

Sporangia long-cylindrical, flexuous, clustered irregularly, sometimes forming patches 6–10 cm. or more in extent, natal-brown \*, 14–23 mm. tall; stem black, polished, enlarged below; columella black, sparingly branched; capillitium open, of brown, sparingly branched threads, bearing a surface net of moderately small, rather uniform meshes mostly under 50  $\mu$  in diameter; peridial processes few, inconspicuous; hypothallus thin but well developed, silvery, common to all the sporangia of a cluster; spores lilaceous brown by transmitted light, verrucose, 8  $\mu$  in diameter. Plasmodium white on maple, creamy on linden.

According to Lister, *S. maxima* Schw. is a synonym of *S. fusca*. Mr. Bilgram, who has examined what is left of Schweinitz' type in Philadelphia, believes it represents the present species, as did Masee, and most of the material distributed as *S. maxima* is the present species. Pending further study it seems wise to retain Rostafinski's name.

The var. *flaccida* Lister seems little more than a growth form in which the sporangia are weak and adherent due to unfavorable weather conditions during development.

On rotten wood, in the United States especially on *Acer saccharinum*, not uncommonly on linden and willow, occasionally on ash. Widely distributed in temperate and tropical regions.

#### 11. *STEMONITIS WEBBERI* Rex

Proc. Acad. Nat. Sc. Phila. 1891 : 390.

Pl. XI, Figs. 264, 265.

1894. *Stemonitis splendens* Rost. var. *webberi* Lister, Mycetoza 112.

Sporangia cylindric with obtuse apex, clustered in small tufts up to 1 cm. broad, sometimes larger, natal-brown \* to bone-brown \*, usually

8–10 mm. tall but occasionally varying from 5–15 mm.; stem jet-black, shining, usually expanded at base into a broad disk with conspicuous rhizoidal outgrowths; columella dark, tapering upward, and becoming dissipated just below tip; capillitium open, peridial net pale, with many large, irregular meshes 50–125  $\mu$  wide; hypothallus continuous, well developed, thin, transparent, or thicker and then silvery; spores bone-brown\* in mass, yellowish brown or lilaceous brown by transmitted light, minutely verruculose, 8–9  $\mu$  in diameter.

The capillitium often possesses numerous membranous expansions near the stipe, as in the type. Distinguished from *S. splendens* by the smaller size, erect habit, pale large-meshed surface net, more ferruginous cast. European authors generally regard this as merely a form of *S. splendens* with large irregular meshes. Brandza (1929) reports it as exceeding 5 cm. in height.

On dead wood, temperate North America, chiefly west of the Mississippi, Cuba. Also reported from Europe, south and west Africa, Manchuria and Japan.

## 12. STEMONITIS AXIFERA (Bull.) Macbr.

N. A. Slime-Moulds ed. 2. 168. 1922.

Pl. XI, Figs. 266, 267.

1791. *Trichia axifera* Bull., Champ. 118. pl. 477, fig. 1.

1818. *Stemonitis ferruginea* Ehr., Sylv. Myc. Berol. 25.

1829. *Stemonitis ferruginea* Ehr. ex Fr., Syst. Myc. 3 : 158, in part.

1894. *Stemonitis microspora* List., in Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 138.

Sporangia cylindrical with acuminate apex, fasciculate in small, dense clusters, wood-brown\* to avellaneous\*, 7–15 mm. tall; stem black, shining,  $\frac{1}{3}$  to  $\frac{1}{2}$  total height; columella branching evenly, dissipated before reaching the tip, branches clear brown, dividing and anastomosing and at the surface uniting to form a fine-meshed peridial net; hypothallus membranous, common to a cluster; spores pallid, faintly ferruginous, spherical or somewhat oval or irregular, nearly smooth, or, under oil immersion, faintly roughened or spinulose, 5–7  $\mu$ . Plasmodium white.

This is *S. ferruginea* Ehr., under which name both it and *S. flavogenita* Jahn are commonly distributed. Bulliard's reference to the white color of the early stages would seem to be distinctive. Fries includes both Bulliard's small-spored form with white plasmodium and a larger-spored form with yellow plasmodium under Ehrenberg's name.

Distribution world-wide; common.



13. *STEMONITIS SMITHII* Macbr.

Bull. Nat. Hist. Iowa 2 : 381. 1893.

Pl. XII, Figs. 268, 269.

1911. *Stemonitis ferruginea* Ehr. var. *smithii* Lister, Mycetozaa ed. 2. 150.

Sporangia subcylindric, larger in center, tapering to base and tip, erect, not spreading, occurring in small, close-packed clusters; light cinnamon-drab \* to vinaceous fawn \*, 2.5–5 mm. in height; stem jet-black, shining, about  $\frac{2}{5}$  of total height; columella dark, becoming brown at tip, gradually tapering and dissolving into capillitium some distance below apex; capillitium light brown, of abundant, sparingly united branches of uniform thickness; peridial net delicate, of small, regular, polygonal meshes with few peridial processes; hypothallus thin but distinct, common to each cluster; spores pale, almost colorless by transmitted light, nearly smooth, but in most cases sparsely and minutely warted when viewed under oil immersion; spherical or slightly irregular, 4–5  $\mu$  in diameter. Plasmodium greenish yellow to reddish purple.

Originally described from Nicaragua, whence we have several collections made by Mr. C. L. Smith and Professor Shimek. Widely distributed in the United States but apparently not common. Miss Lister reports it as a variety of *S. ferruginea* (= *S. axifera*) from a number of old-world localities. It is also reported from Japan.

14. *STEMONITIS FLAVOGENITA* Jahn

Abh. Bot. Ver. Brandenb. 45 : 165. 1904.

Pl. XII, Figs. 270, 271.

1829. *Stemonitis ferruginea* Ehr. ex Fr., Syst. Myc. 3 : 158, in part.1899. *Stemonitis axifera* (Bull.) Macbr., N. A. Slime-Moulds 120, in part.

Sporangia cylindrical, obtuse, closely fasciculate, wood-brown \* at first, becoming natal-brown \* when blown, usually 4–8 mm. tall, sometimes 12 mm.; stipe short, black, passing into a columella which usually ceases abruptly below the apex, often with plate-like proliferations; capillitium a loose network with many broad expansions; peridial net delicate, the meshes small but uneven, 6–15  $\mu$  or larger, with many projecting points; hypothallus common to a cluster; spores lilaceous brown by transmitted light, verruculose, 7–10  $\mu$ . Plasmodium yellow, or occasionally pallid or white.

Distinguished from *S. axifera*, with which it has often been confused, by the usually yellow plasmodium, the larger, more distinctly marked spores, the darker and more vinaceous color and often by the proliferate tip of the capillitium. Apparently less common in the United States

than *S. axifera* but widely distributed, appearing mainly on dead wood.

New England and Pennsylvania to Washington and California; Europe, Java.

15. *STEMONITIS CAROLINENSIS* Macbr.

N. A. Slime-Moulds 122. 1899.

Pl. XII, Figs. 272, 273.

1894. *Stemonitis tenerrima* Curtis ex Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 137, non Curtis.

1911. *Stemonitis pallida* Wingate ex Lister, Mycetozaa ed. 2. 149, in part.

Sporangia tufted in scattered clusters, small, slender, cylindric but tapering from the apex, at first brownish drab \*, then ashen or purplish, stipitate, 7–10 mm. tall; the stipe usually short, black and shining, even; hypothallus well developed, black or very dark brown; columella black, gradually diminishing, at length dissipated some distance below the clavate or acuminate apex of the sporangium; capillitium dense, the inner of many scarcely expanded, pallid, freely anastomosing branches, the outer a net of very small meshes, often less than the spores, 3–15  $\mu$ , peridial processes imperceptible; spore-mass vinaceous, spores by transmitted light pale violaceous brown, very minutely roughened, 6.5–7.5  $\mu$ .

Very closely related to *S. pallida* and *S. herbatica*, but recognizable by its proportionately much more slender, taller, acuminate sporangia, paler and denser capillitium and the remarkably close-meshed net.

Not uncommon south: Virginia, North Carolina, Kentucky, Alabama, Puerto Rico; Congo.

16. *STEMONITIS PALLIDA* Wingate

in Macbr., N. A. Slime-Moulds 123. 1899.

Pl. XII, Figs. 274, 275.

Sporangia gregarious or somewhat clustered, erect, cylindric, obtuse, 4–6 mm. tall, blackish dusky drab and then ferruginous, becoming pallid, stipitate; stipe short, black, polished, rising from a thin, brown or iridescent hypothallus; columella percurrent, ceasing abruptly at the apex; capillitium filling the interior with abundant branches which form at the surface a close-meshed net, little developed above, making the apex very blunt; spores in mass dark brown, by transmitted light dusky, nearly smooth, 7–8  $\mu$ .

This species is well recognized at sight, among the fuscous forms, by its scattered, erect habit. In color it is not unlike *S. fusca*, but has an added reddish tinge. In form it is peculiar by virtue of the blunt

rounded apex, which seems to be a constant character. The spores under a high power lens appear almost smooth; under oil immersion they present very delicate, low, scattered papillæ.

Not common; eastern United States to Iowa, Washington, Oregon; Rumania, Poland, Malay Peninsula, Japan.

#### 17. *STEMONITIS HERBATICA* *Pk.*

Rept. N. Y. State Mus. 26 : 75. 1874.

Pl. XII, Figs. 276, 277.

1899. *Stemonitis axifera* (Bull.) Macbr., N. A. Slime-Moulds 120, in part.

Sporangia clustered, in scattered tufts, cylindric, obtuse, stipitate or sometimes nearly sessile, natal-brown\* or army-brown\* fading to avellaneous, 3-7 mm. tall; stipe fuscous or jet-black, only slightly expanded below, short; hypothallus scanty or none; columella lessening upward, sometimes attaining the apex of the sporangium, sometimes dissolved in capillitial threads some distance below; capillitium of rich brown threads forming the usual inner network of medium density, with many wide expanded nodes, the surface net made up of delicate, almost colorless threads surrounding small polygonal meshes; spore-mass ferruginous; spores by transmitted light very pale, brownish, minutely warted, 7-9  $\mu$ . Plasmodium white to pale yellow.

The low tufts of brown sporangia with short black stipes, borne often as Dr. Peck found them, assembled on living leaves, distinguish this little species. Probably widely distributed, but confused with short forms of other species; sometimes also on rotten wood or débris.

New York, Iowa, Washington, Oregon; Europe, Asia, Africa.

#### 6. *Comatricha* *Preuss* emend. *Rost.*

Vers. 7. 1873.

1851. *Comatricha* Preuss, Linnæa 24 : 140, in part.

Sporangia cylindric or globose, usually stipitate; stipe prolonged upward to form a more or less extended and tapering columella bearing branches on every side, which by repeated divisions and reunions form the capillitium; ultimate branch-tips free, not supporting a surface net parallel to the peridial wall; peridium evanescent, perhaps sometimes not developed at all.

The genus *Comatricha* was set off from *Stemonitis* by the joint efforts of Preuss and Rostafinski. Preuss included in his genus *Comatricha* alien forms, and besides failed to give an accurate definition;

he included, however, in his list some species which have since been known by his generic name.

The distinction between the two genera is admittedly somewhat artificial, and species are sometimes arbitrarily assigned to one genus or the other. The diagnosis in any case turns upon the presence or absence of a surface net. In *Stemonitis* this is formed by the anastomosing of the ultimate divisions of the capillitial branches. In *Comatricha* the anastomosing is general, from the columella out, and is not specialized at the surface. Attempts to reunite the two genera seem to result in no apparent advantage. They come very near together, but their separation as suggested by Rostafinski remains convenient.

## KEY TO THE SPECIES OF COMATRICHA

- |  |                          |
|--|--------------------------|
| a. Peridium iridescent, persistent, at least at the base; stipe very short or lacking.....   | b                        |
| a. Peridium fugacious; stipe distinct.....   | d                        |
| b. Sessile or short-stipitate; clavate-truncate; spores roughly warted.....  | 1. <i>C. caespitosa</i>  |
| b. Sessile; cylindrical; spores reticulate.....  | c                        |
| c. Black; peridium more or less persistent over entire surface; spores 10-12 $\mu$ .....   | 2. <i>C. cylindrica</i>  |
| c. Brown; peridium persistent only at base; spores 8-9 $\mu$ ....  | 3. <i>C. rispaudii</i>   |
| d. Sporangia densely clustered; capillitium scantily branched.....   | e                        |
| d. Sporangia gregarious or scattered; capillitium various.....   | g                        |
| e. Ferruginous, 5-10 mm. tall.....   | 4. <i>C. flaccida</i>    |
| e. Dark brown or blackish.....   | f                        |
| f. Sporangia 10-25 mm. tall; spores roughly warted or reticulate.....  | 5. <i>C. longa</i>       |
| f. Sporangia 3-6 mm. tall; spores echinulate.....  | 6. <i>C. irregularis</i> |
| g. Spores black or dark purplish in mass; violet-brown by transmitted light.....   | h                        |
| g. Spores lilaceous or ferruginous in mass; pallid by transmitted light.....   | u                        |
| h. Capillitium simple, with few or no anastomoses.....   | i                        |
| h. Capillitium intricate.....  | l                        |
| i. Capillitium caducous, falling away with the spiny spores..  | 7. <i>C. filamentosa</i> |
| i. Capillitium persistent, at least above; spores minutely warted or nearly smooth.....  | j                        |
| j. Capillitium moderately dense, but with few anastomoses; columella nearly reaching the summit.....                                   | 8. <i>C. laxa</i>        |
| j. Capillitium looser; columella shorter.....  | k                        |
| k. Very minute, usually under 0.5 mm. tall; columella not exceeding middle of sporangium; capillitium forking repeatedly               | 9. <i>C. cornea</i>      |
| k. Minute, 0.7-1.5 mm. tall; columella very short; capillitium of slender, simple or sparsely branched threads with expanded tips..... | 10. <i>C. fimbriata</i>  |
| l. Spores mostly over 10 $\mu$ .....   | m                        |
| l. Spores mostly under 10 $\mu$ .....  | n                        |



- m.* Robust, truncate, 2-6 mm. tall; stem equal to sporangium or shorter. . . . . 11. *C. suksdorfii*
- m.* Cylindrical or slightly ovate, 7-8 mm. tall; stipe at least half the total height. . . . . 12. *C. pacifica*
- n.* Spores reticulate. . . . . 13. *C. reticulata*
- n.* Spores warted to nearly smooth. . . . . *o*
- o.* Capillitium caducous except at top; spores usually under  $6\ \mu$  14. *C. fragilis*
- o.* Capillitium persistent; spores usually larger. . . . . *p*
- p.* Sporangia distinctly cylindrical. . . . . *q*
- p.* Sporangia globose to ovoid, rarely short cylindrical. . . . . *r*
- q.* Stipe long, equal to sporangium; spores  $7.5-8\ \mu$ . . . . . 15. *C. æqualis*
- q.* Stipe short; spores  $9-10\ \mu$ . . . . . 16. *C. subcæspitosa*
- r.* Usually 2-4 mm. tall. . . . . 17. *C. nigra*
- r.* Under 2 mm. tall. . . . . *s*
- s.* Columella nearly reaching apex. . . . . 18. *C. ellisii*
- s.* Columella shorter. . . . . *t*
- t.* Columella reaching middle of sporangium; spores coarsely warted. . . . . 19. *C. lurida*
- t.* Columella divided at base into several main branches; spores finely spinulose. . . . . 20. *C. elegans*
- u.* Cylindrical; spores with sparsely scattered clusters of warts 21. *C. typhoides*
- u.* Spores more densely and uniformly spinulose. . . . . *v*
- v.* Base of peridium persisting as a cup; globose or elliptical 22. *C. rubens*
- v.* Base of peridium not persistent; ovate to short cylindrical. . . . . *w*
- w.* Capillitium pallid or flesh colored. . . . . 23. *C. tenerrima*
- w.* Capillitium dark. . . . . 24. *C. pulchella*

### 1. COMATRICHA CÆSPITOSA Sturgis

Bot. Gazette 18 : 186. 1893.

Pl. XII, Figs. 278, 279.

1907. *Diachæa cæspitosa* (Sturgis) List., Jour. Bot. 45 : 186.

Sporangia densely crowded or cæspitose, sessile or short-stipitate, clavate, 1-1.5 mm. high; peridium gray, iridescent with blue tints, comparatively permanent but finally disappearing; columella attaining two-thirds to three-fourths the height of the sporangium, giving rise throughout its length to the dense blackish capillitium; hypothallus delicate, inconspicuous; capillitium, the main branches thick at the point of origin, frequently anastomosing, and becoming gradually thinner toward the surface of the sporangium, the tips pointed, free, forming the network; spores blackish violet in mass, by transmitted light pale brownish violet, irregularly verrucose,  $10-13\ \mu$ .

A very distinct and curious species. The sporangia are densely crowded, though by the nature of habitat somewhat tufted. The shape of the individual sporangium is quite uniformly clavate or

obovate, decidedly truncate above. The spores are rather variable in size, the warts also of different sizes and more or less clustered.

This species, as indicated, was described by its author as a comatricha. To transfer it to another genus seems idle, especially when long-established generic boundaries must be seriously disturbed expressly to admit the new arrival.

New England, North Carolina, on moss and lichens.

## 2. COMATRICHA CYLINDRICA (*Bilgram*) *Macbr.*

N. A. Slime-Moulds ed. 2. 173. 1922.

Pl. XII, Figs. 280, 281.

1905. *Diachæa cylindrica* Bilg., Proc. Ac. Nat. Sc. Phila. 524.

Sporangia cylindrical with obtuse apex, sessile, gregarious, iridescent, steel-gray or bronze, 1–1.7 mm. high, 0.5–0.65 mm. thick; hypothallus whitish, rugose; sporangium wall membranous, hyaline, not adhering to the capillitium; columella arising from the hypothallus and extending nearly to the apex, brown, very light and semi-translucent near the base, irregular, flexuous, limeless throughout; capillitium brown, radiating from the columella to the periphery, repeatedly branching and anastomosing; spores warted, the warts connected by ridges forming a more or less perfect, coarse reticulation, violaceous, pale, 10–12  $\mu$ .

This is a very interesting species, closely related to the preceding, from which it differs chiefly in the reticulation and generally more uniform character of the spores. The author hesitated about the generic reference, finally referring it to *Diachæa* despite the lack of calcium, because it was sessile and had a peridium rather more persistent than is usual in comatrichas. But the presence of lime in stipe and columella is an essential element in the diagnosis of *Diachæa*, while length of stem is everywhere variable in stipitate forms of every genus, and the persistence of the peridium is also an uncertain factor.

Pennsylvania, New Hampshire.

## 3. COMATRICHA RISPAUDII *Hagelstein*

Mycologia 21 : 297. 1929.

Pl. XII, Figs. 282, 283.

Sporangia sessile, cylindrical or clavate-cylindrical, clustered in dense groups up to thirty or more sporangia, sometimes superimposed, color brown with a violet tinge, size 0.8–1.5 mm. high, 0.4–0.6 mm. thick; sporangium wall evanescent but persisting at the base and frequently forming pseudo-cups which blend with the hypothallus; columella dark brown, stout at the base but becoming slender, solid,

sinuose and irregular, either extending to the apex or merging with the capillitium; the latter consists of branched and anastomosing brown threads spreading from all parts of the columella and generally coarsely meshed within; spores pale violet-brown, 8-9  $\mu$  in diameter, reticulated with narrow ridges 0.5  $\mu$  high.

Long Island, N. Y., on dead leaves.

#### 4. COMATRICHA FLACCIDA (*Lister*) *Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 133. 1894.

Pl. XII, Figs. 284, 285.

1894. *Stemonitis splendens* Rost. var. *flaccida* Lister, *Mycetozoa* 112.

Sporangia semi-erect, closely crowded in tufts up to 5 cm. in diameter, ferruginous, from a dark brown hypothallus, sessile or short-stipitate; columella weak, crooked, percurrent, generally enlarged irregularly at the apex; capillitium of few, slender, brown branches which anastomose sparsely and irregularly as in *C. irregularis*, and present when freed from spores the same chenille-like appearance; spore-mass ferruginous brown; spores by transmitted light bright reddish brown, minutely warted, 7.5-8  $\mu$ .

"Growing on old wood and bark of oak, willow, etc. The component sporangia 5-10 mm. in length. The early appearance is much like that of a species of *Stemonitis*, but the mature stage is a great mass of spores with scanty capillitium, as in *Reticularia*; the columellas, however, are genuine and not adjacent portions of wall grown together." *Morgan*.

*Morgan's* herbarium material is at hand for study. It meets his description, needless to say, very generally. In what remains of the type the membranous connections are obscure; in fact the relation of such peridial fragments to the capillitium in any way is no longer evident. But in any event the colony does not impress one as something prematurely or improperly developed, a *stemonitis* gone begging;—nothing of the kind; it is clearly a *comatricha*, easily identifiable as such, with no trace of a surface net, but with long free tips in plenty.

Misled, no doubt, by the peridial fragments referred to, *Mr. Lister*, in the *Mycetozoa*, associated this with *S. confluens* Cke. & Ell., but entered it as a variety of *S. splendens* Rost. just the same. In the later editions of the same work, *Ellis' species* is set out, but *Morgan's* retains the old position. In the light of present knowledge, the relationship suggested would be difficult of proof. If *C. flaccida* *Morgan* be related to the *splendens* group at all, it must be with the form

known as *S. webberi* Rex, but it differs from this in almost every particular. It has no net with meshes uniform or diverse; it is clear brown in color, with a tinge of red, beneath the lens; the spores are smaller, distinctly warted and with the reddish tinge of the capillitium; in short, it seems to be a comatricha and not a stemonitis.

Specimens from western Washington differ in some particulars but are apparently the same thing.

Ohio, Kentucky, Wisconsin, Montana, Washington, California; not common. Reported from Europe and temperate regions generally.

#### 5. COMATRICHIA LONGA *Peck*

Rept. N. Y. State Mus. 43 : 24. 1890.

Pl. XIII, Figs. 303, 304.

1892. *Stemonitis longa* (Pk.) Masee, Mon. 83.

1909. *Stemonitis equinoctialis* Welw., in Torrend, Fl. Myx. 138.

Sporangia crowded in depressed masses or tufts, black, stipitate, cylindric, even, 10–25 mm. or more in height; stipe black, shining, generally very short; hypothallus well developed, dark, shining; columella black, slender, weak, generally dissipated some distance below the apex; capillitium of slender brown or dusky threads anastomosing to form an open network next the columella, but extended outwardly in form of long free slender branchlets, now and then dichotomously forked; spore-mass blue-black; spores by transmitted light dark brown, globose, spinulose, sometimes reticulate, 8–10  $\mu$ .

A very remarkable species. Rare in the west, more common, as it appears, in the eastern states. The sporangia occur in tufts about 1 or 2 cm. wide, springing generally from crevices in the bark of decaying logs, especially willow and elm, in swampy places. The sporangia are remarkable for their great length. Generally about 20–25 mm., specimens occasionally reach 50 mm.! The capillitial branches are so remote that the spores are scarcely retained by the capillitium at all.

New York, Pennsylvania, District of Columbia, Ohio, Wisconsin, Iowa, Puerto Rico, Bolivia, Argentina; Europe, Africa, southern Asia, Japan.

#### 6. COMATRICHIA IRREGULARIS *Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 393.

Pl. XII, Figs. 286, 287.

1893. *Comatricha crypta* (Schw.) Macbr., Bull. Lab. Nat. Hist. Iowa 2 : 139.

1894. *Comatricha longa* Pk. var. *irregularis* Lister, Mycetozaa 120.

Sporangia crowded in flocculent tufts, dark brown or black, semi-erect or drooping, 3–6 mm. in height, irregularly cylindric, variable,



stipitate; stipe black, distinct, often one-half the total height; hypothallus well developed, brown, shining; columella central, slender, flexuous, reaching the apex, where it blends, by branching, with the capillitium; capillitium loose, open, composed of arcuate threads which radiate from the columella, and are joined together, forming a central, irregular reticulation of large meshes, brown, paler toward the surface, where the free ends are sometimes colorless; spore-mass black; spores by transmitted light brown, echinulate,  $7.5-9.5\ \mu$ .

Related, no doubt, to *C. longa*, but differing in habit, stature, as in texture and structure of the capillitium. In *C. longa* the inner net is extremely simple, a row or two of meshes at most, and the radiating branches are long and straight; in the species before us the inner network is well developed, and the radiating branches proportionately shorter and abundantly branching, with pale or white free tips.

This species has been widely distributed as *C. crypta* based on *Stemonitis crypta* Schw. (Trans. Am. Phil. Soc. II. 4 : 260, 1832.) The type of Schweinitz' species is lost and the description is not clear, hence the name should be discarded.

Generally, though not always, found growing in the crevices of the bark on fallen logs of various deciduous trees. Not common.

New England west to the Cascade Mountains, south to Kansas and Texas, Puerto Rico.

#### 7. COMATRICHA FILAMENTOSA Meylan

Bull. Soc. Vaud. Sc. Nat. 53 : 456. 1920.

1911. *Comatricha nigra* (Pers.) Schroet. var. *alta* Lister, Mycetozoa ed. 2. 152, in part.

Sporangia dark brown, in large clusters, elliptical or subglobose, 0.8-1 mm. tall, borne on stems 0.5-1 mm. long; columella reaching to summit, where it is sometimes slightly enlarged as in *Enerthenema*; capillitium in the form of an interrupted net of anastomosing, sparsely branched, smooth, brown filaments of uniform size, very weakly attached to the stipe and falling away with the spores at maturity; spores brown, spiny,  $10-12\ \mu$ .

Regarded by Lister as a phase of *Comatricha nigra* var. *alta*. Meylan considers it related to *C. laxa*. The caducous capillitium separates it from the former species; the spore-size from both.

Switzerland.

## 8. COMATRICHA LAXA Rost.

Mon. 201. 1875.

Pl. XII, Figs. 288, 289, 290.

1877. *Lamproderma ellisiana* Cooke, Ann. Lyc. Nat. Hist. N. Y. 11 : 397.1884. *Comatricha macrosperma* Racib., Rozpr. Akad. Krak. 12 : 76.1891. *Comatricha ellisiana* (Cke.) Ell. & Ev., N. A. Fungi No. 2696.1892. *Comatricha sommerfeltii* Blytt, Bidr. K. Norg. Sop. 3 : 8.1892. *Stemonitis laxa* (Rost.) Masee, Mon. 79.

Sporangia scattered, gregarious, subglobose or short-cylindric and obtuse, dusky, stipitate, 1–2.5 mm. tall; stipe short, black, tapering rapidly upward from an expanded base; hypothallus scant or none; columella erect, rigid, sometimes reaching nearly to the apex of the sporangium, sometimes dichotomously branched a little below the summit before blending into the common capillitium; capillitium lax, of slender, horizontal branches, anastomosing at infrequent intervals and ending in short, free tips; spores purplish brown, minutely warted, 7–11  $\mu$ .

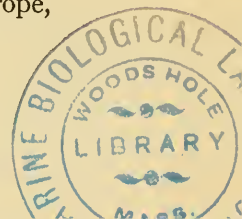
A minute, delicate little species; the stipe half the total height. In general appearance the shorter forms resemble *C. nigra*, but are distinguished by a shorter stipe and more open capillitium. The sporangia of *C. nigra* mounted on long capillary stipes always droop more or less; the sporangia of the present species stand rigidly erect. The sporangia vary in form and in the branching of the columella. In the more globose phases, the columella almost always shows a peculiar dichotomy near the apex; in the cylindric types, this peculiar division fails. In fact, the shape is determined chiefly by the mode of branching of the columella. Rostafinski's figure, on pl. XIII, does not present the type usually seen in this country, nor even in Europe if we may judge from later illustrations. Čelakowsky's illustrations (Myx. Böhm. pl. 2, figs. 7, 8) are better.

The species with us has received various names, but so far as can be determined, all apply to the same thing, and comparison of specimens from Mr. Ellis with those from Europe shows the correctness of the nomenclature here adopted.

The var. *rigida* Brandza is characterized by scanty, rigid capillitium and slightly larger spores.

Forms with larger spores have been reported, including a form with very minute globose sporangia, a scanty capillitium and spores 12–14  $\mu$  in diameter, described by Meylan (Bull. Soc. Vaud. Sc. Nat. 53 : 456, 1920) as var. *microcarpa*. This may prove to be distinct.

Rare, but widely distributed in North America; also Europe, Malay Peninsula, Manchuria, Japan.



9. COMATRICHA CORNEA *G. List. & Cran.*

Jour. Bot. 55 : 121. 1917.

Sporangia scattered or solitary, stalked, globose, 0.12–0.32 mm. in diameter; stalk subulate, straight, slender, 0.17–0.2 mm. high, dark brown above, brownish yellow below where it expands into a discoid hypothallus; columella brown, cylindrical, reaching one-third to one-half the height of the sporangium, with a small collar where it meets the stalk, dividing above into two or three primary branches of the capillitium; branches forking repeatedly and ending at the surface in short, rigid, diverging branchlets; spores gray, minutely warted, the spore wall thinner on one side, 8.5–9  $\mu$ .

Scotland, Germany, Switzerland.

10. COMATRICHA FIMBRIATA *G. List. & Cran.*

Jour. Bot. 55 : 122. 1917.

Sporangia scattered, stalked, globose, blackish brown, 0.1–0.35 mm. in diameter; stalk black, subulate, slender, straight or curved, 0.5–1 mm. high; capillitium arising chiefly from the summit of a short truncate columella, consisting of a scanty tuft of purplish brown threads, extremely slender at the base, simple or forking below the clavate or irregularly expanded tips; spores grayish purple, closely and minutely spinulose, paler and smoother on one side, 10–12  $\mu$ . Plasmodium colorless.

Collected from several localities in Iowa by Mr. H. C. Gilbert and the junior author on the bark of trees brought into the laboratory where it develops after a few days in a moist chamber. The curious capillitium is like that of no other species. Aside from the Iowa collections, known only from England and Scotland.

11. COMATRICHA SUKSDORFII *Ellis & Everh.*

Bull. Lab. Nat. Hist. Washburn Coll. 1 : 5. 1884.

Pl. XII, Figs. 291, 292.

1892. *Stemonitis suksdorfii* (Ell. & Ev.) Massee, Mon. 76.1894. *Comatricha obtusata* Preuss ex List., Mycetozoa 117.1907. *Comatricha nigra* (Pers.) Schroet. var. *suksdorfii* Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 33. 1907.

Sporangia scattered in small tufts or gregarious, cylindric or clavate, obtuse at both ends, black, 2–6 mm. tall, stipitate; stipe jet-black, shining, even, usually about one-half the total height, sometimes shorter; hypothallus not continuous, dark brown; columella black, rather slender, terminating in two or more large branches just below

the apex; capillitium arising from entire length of columella, exceedingly dense, dark fuscous or black, the flexuous threads anastomosing in a close network, with abundant free pallid extremities; spores in mass blue-black, by transmitted light fuscous or dark violaceous brown, paler on one side, minutely warted, 10–12  $\mu$ .

Easily recognizable at sight by its sooty color. Entirely unlike any of the preceding. The capillitium is similar to that of *C. pulchella*, but it is very much more dense and entirely different in color. The sporangia are often widened above and fairly truncate; the total height up to 6 mm. The peridium is colorless, usually evanescent, but sometimes long-persistent; when free, white or silvery.

Var. *aggregata* Meylan has the sporangia confluent, on very short stipes, and a more lax capillitium. It is connected by intermediate forms with the typical form, and seems unworthy of recognition.

On coniferous wood, Washington, Oregon, Colorado; Switzerland.

## 12. COMATRICHA PACIFICA *Macbride*

Amer. Jour. Bot. 19 : 139. 1932.

1922. *C. æqualis* Peck var. *pacifica* Macbr., N. A. Slime-Moulds ed. 2. 181.

Sporangia gregarious, erect, deep violaceous, cylindrical or slightly ovate, 7–8 mm. tall, stipitate; stipe about half the total height, black, polished, even; hypothallus dark brown, shining, conspicuous, more or less distinct for each sporangium, often connected in plasmodiocarpous fashion but not continuous; columella dark, tapering, attaining almost the summit of the sporangium; capillitium dense, of dark flexuose threads, branching repeatedly and forming an intricate network, the free ends numerous, short, little if any paler than the threads from which they arise; spores dark violaceous, distinctly warted, 9.5–11  $\mu$ .

Resembling *C. æqualis*, of which it was formerly regarded as a variety, but larger, darker, more distinctly purple, and with a different hypothallus and larger spores.

Oregon, M. E. Peck.

## 13. COMATRICHA RETICULATA *Gilbert*

Amer. Jour. Bot. 19 : 140. 1932.

Sporangia dark lilac-brown, in small loose tufts, erect, on a thin silvery hypothallus, 1.5–3 mm. tall, short-cylindric and obtuse at both base and apex; stipe about one-half the height, black, shining; columella dissipating in the upper one-fourth of the sporangium; primary branches of the capillitium numerous, often thickened near the columella, and branching and anastomosing to form an irregular



net toward the surface which retains the form of the sporangium after spore dispersal; free tips outside the net short and abundant; spores pale lilac-brown, strongly reticulate with meshes of irregular size,  $7-9\ \mu$  in diameter.

The network of the capillitium suggests *Stemonitis* but is decidedly not on the surface, as is shown by the many free tips outside the net. The beautifully reticulate spores constitute the most striking characteristic of this species.

Oregon. On rotting coniferous wood.

#### 14. *COMATRICHA FRAGILIS* Meylan

Bull. Soc. Vaud. Sc. Nat. 56 : 70. 1925.

1910. *Comatricha laxa* Rost. var. *microspora* Torrend, Bull. Soc. Vaud. Sc. Nat. 46 : 50. 1910.

Sporangia in groups, sometimes rather large, sooty, 2 mm. tall, subcylindrical, borne on a stalk equally or almost as long; columella attaining summit of sporangium; capillitium as in *C. nigra* but falling with the spores and leaving the columella naked except at the summit where it sometimes remains attached longer as in *Enerthenema*; spores sooty,  $4-6\ \mu$ , rarely  $5-8\ \mu$ .

An authentic collection from Dr. Meylan has spores of nearly uniform size, averaging  $7.5\ \mu$ . The sooty sporangia with the capillitium persistent only in the upper part are as described.

Jura Mountains, Switzerland.

#### 15. *COMATRICHA ÆQUALIS* Peck

Rept. N. Y. State Mus. 31 : 42. 1879.

1892. *Stemonitis æqualis* (Pk.) Masee, Mon. 80.

1907. *Comatricha nigra* (Pers.) Schroet. var. *æqualis* Pk. ex Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 34.

Sporangia gregarious, seldom erect, usually inclined, curved or nodding, dark brown, becoming violet, cylindric, acuminate-obtuse,  $4-6$  mm. tall, stipitate; stipe about half the total height, black, polished, even; hypothallus well developed, brown, continuous; columella black, tapering gradually, and attaining almost the summit of the sporangium; capillitium dense, of flexuous tawny threads which, by repeated branching, form an intricate network, the free extremities numerous, short and pale; spores dark violaceous, distinctly warted,  $7.5-8\ \mu$ . Plasmodium milky white.

A very graceful, elegant species, related to *C. pulchella*, but distinct by its much greater size and smaller spores. The specimens before us show the perfection of beauty in this genus; the polished stipe, the

symmetrical capillitium, the soft purple-brown tints are remarkable, and enable one to recognize the form at sight.

New York, Pennsylvania, Ohio, Illinois; Rumania.

16. *COMATRICHA SUBCÆSPITOSA* Peck

Rept. N. Y. State Mus. 43 : 25. 1890.

Pl. XII, Figs. 295, 296.

1892. *Stemonitis subcæspitosa* (Pk.) Masee, Mon. 80.

1894. *Comatricha obtusata* Preuss ex Lister, Mycetoza 118, in part.

1909. *Comatricha persoonii* Rost. var. *subcæspitosa* Peck, ex Torrend, Fl. Myx. 137.

1922. *Comatricha nigra* Schroet. var. *subcæspitosa* Lister, Mycetoza ed. 3. 142.

Sporangia scattered or sometimes in loose clusters, cylindric, obtuse, 1.5–2 mm. tall, dark brown, stipitate; stipe short, one-fifth total height; hypothallus minute; capillitium regular, the branching quite uniformly parallel, flexuous, brown with a tinge of violet, not dense; columella well defined, almost percurrent; spores brown in mass, under lens dusky, nearly smooth, 8–10  $\mu$ .

The larger spores, regular, erect form, and clustered habit separate this form from others with which it will be naturally associated.

Nova Scotia, New York, California?; Europe?.

17. *COMATRICHA NIGRA* (Pers.) Schroet.

in Cohn, Krypt. Fl. Schles. 3 (1) : 118. 1885.

Pl. XII, Figs. 297, 298.

1791. *Stemonitis nigra* Pers., in Gmel., Syst. Nat. 2 : 1467.

1794. *Stemonitis atrofusca* Pers., Roemer N. Mag. Bot. 1 : 91.

1801. *Stemonitis ovata* Pers., Syn. Meth. Fung. 189.

1803. *Trichia mucoriformis* Schum., Enum. Pl. Sæll. 2 : 211.

1829. *Stemonitis oblonga* Fr., Syst. Myc. 3 : 159.

1875. *Comatricha friesiana* Rost., Mon. 199.

1893. *Comatricha persoonii* var. *gracilis* Čel. fil., Myx. Böhm. 50, pl. 2, figs. 4, 5.

Sporangia scattered, ferruginous or dark brown, globose or ovoid, stipitate, mostly 2–4 mm. tall; stipe long, hair-like, tapering upward, black; hypothallus none; columella rapidly diminished toward the top, at length dissipated; capillitium of slender flexuous threads radiating horizontally, repeatedly branching and anastomosing to form an intricate dense network, from the surface of which project a few short hook-like peridial processes; spore-mass black; spores by transmitted light dark violaceous, smooth or nearly so, 7–10  $\mu$ . Plasmodium colorless, then white.

This species, when typical, is easily recognized by its almost globose sporangia mounted on long slender stalks. These are 2 or 3 mm. high

and generally persist, as Persoon noticed, a long time after the sporangium has fallen. The sporangia are at first black; after spore dispersal pale ferruginous. In shape they vary from ovate to spherical. Sometimes they are umbilicate below, so that a vertical section would be obcordate. Care must be taken to distinguish the present species from blown-out forms of *Lamproderma*.

This most common species seems to be also the center of widest differentiation. In a valuable paper on the Myxomycetes of Dr. C. H. Peck's herbarium, Dr. Sturgis (1900) points out the varying relationships of a group of surrounding forms. According to his account *C. nigra* approaches *C. laxa* at one extreme, *C. æqualis*, which the Listers enter as varietal here, at the other. However, in the former the more rigid, direct and simple branching from the columella is usually determinative; in the latter the color, form and generally more delicate structure, and a tendency to grow in tufts will serve to distinguish it.

In this discussion we have assumed as typical the globose sporangium, with the variations in the direction of ovate, obovate, ellipsoidal, etc., the capillitium flexuous and more richly anastomosing near the columella. On the drier slopes in the mountains of Colorado specimens are especially abundant, in proper season covering apparently the lower surface of every barkless twig or fallen stem or even entire trees. In such a field one might imagine every possible variation open to observation. Probably such is the case; but as a matter of fact a single small plasmodium at lower levels will sometimes show greater range of variation than was noted on the mountain side. The cylindric forms were for some reason few, and when noted were short, though often surmounting stems of double the usual length.

Rostafinski calls this *C. friesiana*, using the specific name suggested by de Bary. By this name the species was commonly known for many years. It was previously distributed by Rabenhorst as *Stemonitis friesiana* de Bary, but this name seems not to have been validly published. More recently some writers prefer *C. obtusata* Preuss; but *C. obtusata* Preuss, as figured by that author (Sturm's Deutsch. Fl., pl. 70), is surely more likely *Enerthenema papillatum*, and the author says in his description "capillitio vertice soli innato." Persoon certainly recognized the species, and his description, though brief, is yet applicable to no other European species. There seems no reason why the name he gave should not be permanently adopted. Rostafinski's figure, pl. XIII, shows an ellipsoidal sporangium, not cylindric.

A form with very short stipe and large spores, 10–11  $\mu$ , was described by Meylan as the var. *brachypus*. Later, finding the characters con-

stant, he proposed it as a distinct species, *C. brachypus* (Bull. Soc. Vaud. Sc. Nat. 57 : 41, 1929).

*C. nigra* is widely distributed and not uncommon, but often overlooked. Eastern United States to Colorado and on the Pacific coast, Bolivia, Brazil, Argentina; widely distributed in the old world.

18. COMATRICHA ELLISII *Morg.*

Jour. Cin. Soc. Nat. Hist. 16 : 133. 1894.

1899. *Comatricha laxa* Rost. ex Macbr., N. A. Slime-Moulds 127, *non* Rost.

1911. *Comatricha nigra* (Pers.) Schroet., ex Lister, Mycetozaa ed. 2. 152, in part.

1922. *Comatricha laxa* Rost. ex Lister, Mycetozaa ed. 3. 143, in part.

Sporangia short, erect, oval or ovoid to oblong, total height 0.6–1.5 mm.; stipe and columella erect, brown and smooth, rising from a thin pallid hypothallus, tapering upward and vanishing into the capillitium toward the apex of the sporangium, the stipe usually longer than the columella; capillitium of slender pale brown threads which branch several times with lateral anastomosing branchlets, forming a rather open network of small meshes, ending with very short free extremities; spores globose, even, pale ochraceous, 6–7  $\mu$ .

Growing on old pine wood, the sporangium 0.3–0.6 mm. in height by 0.3–0.5 mm. in width, the stipe usually a little longer than the sporangium.

On the strength of the clear descriptions and beautiful drawings of Čelakowsky, Myxomyceten Böhmens, p. 52, pl. 2, figs. 7 and 8, this elegant little species was formerly referred to *C. laxa* Rost. It was then reported from New Jersey only. Since then we have specimens from southern Missouri, all true to form, almost identical. It seems wise accordingly, while recognizing the relationship of the form both to *C. laxa*, and to *C. nigra*, to give it here an individual place again. It is very small; but once studied may thereafter be easily recognized by a hand lens. The form is definite, clean cut, and the spores are distinctly smaller than in either of the two related species.

Rare. New Jersey, Missouri.

19. COMATRICHA LURIDA *Lister*

Mycetozaa 119. 1894.

Total height 1.25 mm.; sporangia scattered, globose or shortly ovoid, erect, 0.5 mm. in diameter, stalked, purplish brown; sporangium wall evanescent; stalk setaceous, black, shining, 0.75 mm. long, rising from a circular brown hypothallus; columella cylindrical, reaching to



half the height of the sporangium, dividing into stout branches at the apex and continued into the capillitium; latter dark purplish brown throughout, spreading from the upper part of the columella in flexuous anastomosing threads, with slender brown free ends; spores spherical or subovoid, purplish gray, coarsely warted, 6-10  $\mu$ .

The range of spore-size, as given by Lister, is rather wide. The species is said to resemble *Lamproderma scintillans*.

Europe, Japan.

## 20. COMATRICHA ELEGANS (*Racib.*) *List.*

Guide Brit. Mycetoza ed. 3. 31. 1909.

Pl. XII, Figs. 299, 300.

1884. *Rostafinskia elegans* Racib., Rozpr. Akad. Krak. 12 : 77.

1888. *Raciborskia elegans* Berl., Sacc. Syll. Fung. 7 : 401.

Sporangia loosely gregarious, globose, stipitate, purplish brown, 0.3-0.5 mm. in diameter, 1-2 mm. in total height; stipe black, subulate, to 1.6 mm.; columella at first divided into a few main branches, from which by repeated subdivision the delicate, anastomosing, flexuose capillitial threads take origin; spores pale brownish violaceous, spinulescent, 8-10  $\mu$ .

In a collection from Virginia, the silvery peridium tends to persist, as in a lamproderma.

New Jersey, Virginia, South Carolina, Colorado, Washington; Europe, southern Asia, Japan.

## 21. COMATRICHA TYPHOIDES (*Bull.*) *Rost.*

Vers. 7. 1873.

Pl. XII, Figs. 293, 294.

1791. *Trichia typhoides* Bull., Champ. 119. pl. 477, fig. 2.

1805. *Stemonitis typhoides* (Bull.) DC., Fl. Fr. 2 : 257.

1842. *Stemonitis pumila* Corda, Icones 5 : 59.

1875. *Comatricha typhina* Rost., Mon. 197.

1875. *Comatricha affinis* Rost., Mon. 202.

1885. *Comatricha stemonitis* (Scop.) Wettst., Verh. Zool.-Bot. Ges. Wien 35 : 534.

1892. *Stemonitis affinis* Masee, Mon. 76.

1892. *Stemonitis atra* Masee, Mon. 78.

1892. *Stemonitis carlylei* Masee, Mon. 84.

1899. *Stemonitis platensis* Speg., Anal. Mus. Nac. Buenos Aires 6 : 202.

Sporangia gregarious or scattered, stipitate, cylindrical or sometimes narrowly ovate, erect or sometimes arcuate, obtuse, 2-3 mm. high, at first silvery, then brown as the peridium vanishes; stipe black, about one-half the total height or less; hypothallus distinct, more or

less continuous, reddish brown; columella tapering upward, black, attaining more or less completely the apex of the sporangium; capillitium arising as rather stout branches of the columella, soon taking the form of slender, flexuous, brownish threads, which by repeated anastomosing form at length a close network, almost as in *Stemonitis*, the free, ultimate branches very delicate and short; spore-mass dark brown; spores by transmitted light pale, almost smooth, except for the presence of a few scattered but prominent clusters of warts, of which four or five may be seen at one time, 5–7.5  $\mu$ .

This is our most common North American species. It occurs everywhere on decaying wood, sometimes in remarkable quantity, thousands of sporangia at a time; sometimes on leaves. The plasmodium, watery white in color, infests preferably very rotten logs of *Quercus*, on which in June the sporangia rise as white or pallid columns. The peridium is usually exceedingly delicate, less seldom seen here than in some other species, it is true, but easily overlooked; occasionally it tends to persist. The spores when fresh have a distinct violet or bluish tinge; in old specimens they are almost colorless. In any case they are well marked by the clustered warts.

This is probably *Mucor stemonitis* Scopoli (1772), although the description is scarcely diagnostic. But Scopoli, by citing Hall, Gleditsch and Micheli, so defines the form as to leave small doubt that he had before him our common species. Schaeffer's figures also come to the rescue, which, though by no means satisfactory, yet can probably refer to no other species. *Stemonitis typhina* Wiggers (1780) also seems to be this species and this specific name is adopted by Persoon and Rostafinski. However, Bulliard gives the first good account and figure, and in accordance with the decision of our English colleagues, the name used in the famous *Champignons* is here retained.

Widely distributed. Nova Scotia to Washington, south to Nicaragua, British Guiana, Brazil and Argentina; common in the old world.

## 22. COMATRICHA RUBENS *Lister*

Mycetozoa 123. 1894.

Sporangia gregarious, globoid or ellipsoidal, 1–1.5 mm., pink-brown, stipitate; peridium persistent below; stipe 0.5–1 mm., black, shining; columella more than half the sporangium in height, giving off on all sides the brownish violaceous, flexuose threads of the capillitium, somewhat thickened and broadly attached to the persisting peridial cup; spores lilac-brown, spinulose, 7–8  $\mu$ .

Somewhat resembling a lamproderma, but the capillitium arising

from all parts of the columella. Close to *C. pulchella*, but distinguished by the elliptical or globose peridium and its persistent base.

Pennsylvania, Colorado; Great Britain, Switzerland.

23. *COMATRICHA TENERRIMA* (Curt.) G. List.

Guide Brit. Mycetozaa ed. 4. 39. 1919.

1848. *Stemonitis tenerrima* Curt., Am. Jour. Sc. II. 6 : 352.

1911. *Comatricha pulchella* (Bab.) Rost. var. *tenerrima* List., Mycetozaa ed. 2. 156.

Sporangia scattered, stalked, ovoid or cylindrical, pale red, brownish pink or lilaceous, equalling or shorter than the slender black stalks; total height 1.5–2 mm.; columella slender, often reaching the summit of the sporangium; capillitium a network of slender, flexuose, pale red threads; spores pale flesh colored, minutely warted, 7–8  $\mu$ .

On dead herbaceous stalks and dead wood. Pennsylvania, South Carolina, Antigua, Brazil; Europe, Japan.

24. *COMATRICHA PULCHELLA* (Bab.) Rost.

Mon. App. 27. 1876.

Pl. XIII, Figs. 301, 302.

1837. *Stemonitis pulchella* Bab., Trans. Linn. Soc. 1 : 32.

1875. *Comatricha persoonii* Rost., Mon. 201.

Sporangia very minute, 1–1.5 mm. high, scattered, ovate to short-cylindric, acuminate, pale brown or ferruginous, stipitate; stipe short, black, nearly even; hypothallus none, or merely a circular base to the tiny stem; columella straight, gradually tapering, reaching almost if not quite the apex of the sporangium; capillitium dense, a network of flexuous brown threads, rather broad within, ending in slender tips without; spore-mass brown; spores by transmitted light pale "lilac-brown," or pale ferruginous, minutely but uniformly warted, 6–8  $\mu$ . Plasmodium colorless.

The var. *fusca* Lister is said to have a darker and more rigid capillitium. Var. *gracilis* Lister is narrowly cylindrical, with partially formed surface net and smaller spores.

Probably widely distributed but rarely collected. New Jersey, Pennsylvania, Ontario, Ohio, Iowa, Missouri, Colorado, Bolivia; Europe, Nigeria, southern Asia, Japan.

FAMILY LAMPRODERMACEÆ

Sporangia distinct, usually gregarious, more or less spherical, usually stalked; columella typically present, rarely absent; capillitium composed of slender, more or less branching threads, arising chiefly

or solely from the summit of the columella, when latter is present, otherwise from the base of the sporangium.

The typical members of this family are very close to the Stemonitaceæ. Certain species of *Lamproderma* and of *Comatricha* approach the other genus rather closely. In general, however, the lamprodermas have the capillitial branches concentrated at or near the tip and possess a more persistent and usually iridescent membrane.

The genus *Diacheopsis*, judging from the description, is a sessile or nearly sessile lamproderma without columella. *Echinostelium* may or may not belong in this family, but may at least be temporarily accommodated.

KEY TO THE GENERA OF THE LAMPRODERMACEÆ

- a. Sessile on a broad base or short-stalked; columella lacking.. 1. *Diacheopsis*
- a. Stipitate, or rarely sessile on a narrowed base; columella present..... b
- b. Columella percurrent; capillitium arising from a disk at its apex..... 2. *Enerthenema*
- b. Columella rarely exceeding the center of the sporangium..... c
- c. Columella very short; capillitium forking but not forming a net..... d
- c. Columella  $\frac{1}{3}$  to  $\frac{1}{2}$  the height of the sporangium..... e
- d. Minute, 100  $\mu$  or less in height; capillitium rudimentary.. 3. *Echinostelium*
- d. Larger; capillitium brush-like, rigid, the threads bearing circular disks at their tips derived from the sporangium wall..... 4. *Clastoderma*
- e. Peridium dark, dehiscing in persistent lobes; capillitium dark, scanty, simple..... 5. *Barbeyella*
- e. Peridium iridescent, fragile; capillitium dense, often branching and anastomosing freely..... 6. *Lamproderma*

1. *Diacheopsis Meylan*

Bull. Soc. Vaud. Sc. Nat. 57 : 149. 1930.

Sporangia globose, sessile or stalked; peridium membranous, persistent, shining with metallic luster; columella lacking; capillitium of branching and anastomosing threads as in *Lamproderma*, but these arising from the base of the sporangium; spores dark.

Except for the absence of a columella the genus appears to be very close to *Lamproderma*.

A single species:—

DIACHEOPSIS METALLICA *Meylan*

Bull. Soc. Vaud. Sc. Nat. 57 : 149. 1930.

Sporangia clustered, subglobose, sessile, broader than high, 1–2 mm. in diameter, dark blue, with metallic green, pale blue, purple or gold



reflections; peridium membranous, transparent, free from the capillitium as in *Lamproderma*; columella completely lacking; capillitium arising from the base of the sporangium, the filaments almost colorless, anastomosing, especially toward their outer ends, and frequently with triangular enlargements at the junctions; spore-mass bluish black; spores blackish purple, covered with cylindrical papillæ  $1\ \mu$  in length,  $12\text{--}14\ \mu$  in diameter.

Swiss Alps.

## 2. *Enerthenema* Bowman

Trans. Linn. Soc. 16 : 152. 1828.

Sporangia stipitate, the stipe extended as a columella, which entirely tranverses the sporangium and forms at the apex an expanded disk; from this depends the capillitium.

### KEY TO THE SPECIES OF ENERTHENEMA

- a.* Color fuscous to violaceous or ferruginous; spores minutely warted, not clustered. . . . . 1. *E. papillatum*
- a.* Color black; spores rough. . . . . *b*
- b.* Spores not clustered, dark, coarsely verrucose. . . . . 2. *E. melanospermum*
- b.* Spores clustered; exposed area long-spinescent. . . . . 3. *E. berkeleyanum*

### 1. *ENERTHENEMA PAPILLATUM* (Pers.) Rost.

Mon. App. 28. 1876.

(as *E. papillata*)

Pl. XIII, Figs. 305, 306.

1801. *Stemonitis papillata* Pers., Syn. Meth. Fung. 188.

1828. *Enerthenema elegans* Bowman, Trans. Linn. Soc. 16 : 152.

1888. *Ancyrophorus crassipes* Raunk., Bot. Tidsskr. 17 : 93.

Sporangia fuscous, becoming more or less ferruginous when blown, globose, stipitate, 0.5–0.7 mm. in diameter, 1–1.5 mm. tall, tipped with the small, shining cupulate or rarely papillate apex of the columella; stipe black, opaque, attenuate above, about equal to the peridium; the basal portion of the sporangium wall often remaining as a ring around the stem after dehiscence; columella slender, cylindrical, unbranched, expanding at the apex into a disk from which the capillitial threads arise; these long, slender, sparingly branched, more or less flexuose, dark with free tips; spores olivaceous fuscous, minutely warted,  $10\text{--}12\ \mu$ .

The papilla referred to in descriptions, and from which the name is derived, seems to be nothing more than the disk-like top of the cap-

illitium, from which the sporangial mass has slipped, leaving it protruding slightly.

Meylan has described a variety *carneogriseum* (Bull. Soc. Vaud. 51: 268, 1917) as differing from the typical form by its rose-gray or violet sporangia. We have collections that approach that condition, but they merge into the typical condition.

Not common but widely distributed. From Pennsylvania and South Carolina to Iowa, Colorado and Washington, Chile; throughout the north temperate zone.

## 2. ENERTHENEMA MELANOSPERMUM *Macbride & Martin*

Jour. Wash. Acad. Sc. 22 : 91. 1932.

Pl. XIII, Figs. 307, 308.

Sporangia intense black, gregarious in small clusters of three to a dozen, these in larger aggregations, globose or oval, stalked, 0.8 to 1 mm. in diameter, total height 2 mm. or more; stipe black, shining, rather stout, attenuated upward and continued as a slender, unbranched columella capped with a very large, shining, infundibuliform terminal disk, up to 0.5 mm. in diameter; capillitium dense, black, rather freely branched, arising from terminal disk and with ends free; spores free, dark olivaceous, coarsely warted, 12–14  $\mu$ .

Obviously close to *E. papillatum* but clearly distinct by reason of its large size, the intense and permanent black color, the very large apical disk, and the large, dark, very rough spores.

Oregon, Washington.

## 3. ENERTHENEMA BERKELEYANUM *Rost.*

Mon. App. 29. 1876.

(as *E. berkeleyana*)

1913. *Enerthenema syncarpon* Sturgis, Colo. Coll. Pub. Sc. Ser. 12 : 448.

1925. *Enerthenema papillatum* Rost. var. *syncarpon* List., Mycetozoa ed. 3. 150.

Sporangia jet-black, gregarious or scattered, globose, stalked, rather small, diameter 0.4–0.7 mm., height 0.8–1 mm.; stipe black, extending into columella which is tipped by a small shining disk from which the black, coarse, rough, sparsely branched, flexuose capillitium descends; spores in clusters of 4–12, very spiny on exposed surfaces, nearly smooth elsewhere, becoming globose when separated and then 11–13  $\mu$  in diameter.

Distinct from *E. papillatum* in color, and capillitial and spore characters.

Rare: South Carolina, Colorado, also two collections from Long

Island reported by Mr. Hagelstein, in both cases on lumber from other localities, one of these being Nova Scotia.

### 3. *Echinostelium de Bary*

in Rost., Versuch 7 : 1873.

Sporangia distinct, globose, minute, the structure limited to a few imperfect rib-like, loosely joined branches developed from the short columella or stem-top, sustaining the spores.

A single species:—

#### *ECHINOSTELIUM MINUTUM de Bary*

in Rost., Mon. 215. 1875.

Pl. XXI, Figs. 552, 553.

Sporangia distinct, scattered, globose, very minute, 40–50  $\mu$ , stipitate; stipe hair-like, subulate, granular but hyaline; columella minute or none; capillitium consisting of a few arcuate spinose threads, loosely united, supporting the uncovered spores; spores globose, pinkish or colorless, smooth, 7–8  $\mu$ .

Originally discovered by de Bary in Germany, it has since been reported from several localities in Great Britain, Austria and Rumania. In North America it has been collected from five widely scattered localities, once by Professor Thaxter on a laboratory culture from Maine, again by Mr. Bilgram in Philadelphia and a number of times by the junior author and by Mr. H. C. Gilbert on bark and wood from Vermont, West Virginia and Iowa. Apparently common and widespread, but because of its extreme minuteness rarely reported.

### 4. *Clastoderma Blytt*

Bot. Zeitung 38 : 343. 1880.

Sporangium globose, distinct, stipitate; columella short or obsolete; capillitium of few sparsely branched threads, which bear at their tops the persistent fragments of the peridium, but are not otherwise united.

Distinguished from *Lamproderma* by the peculiar manner in which the peridium is ruptured, and by the simplicity of the scanty capillitium. So far there appears to be but a single species.

#### *CLASTODERMA DEBARYANUM Blytt*

Bot. Zeitung 38 : 343. 1880.

Pl. XXI, Fig. 554.

1886. *Orthotricha microcephala* Wing., Jour. Myc. 2 : 125.

Sporangia scattered or gregarious, very minute, 0.1 to 0.2 mm. in diameter; peridium fugacious, except for the minute circular or po-

lygonal patches that adhere to the capillitial branchlets, and the slight annulus at the base of the columella; stipe long, unequal, dark below, above paler; columella almost none, giving rise to the comparatively few slender threads which by their repeated forking make up the capillitium; spores globose, even, violaceous, 8–9  $\mu$ .

Reported in the United States so far from Maine, New York, Pennsylvania, Ohio, Illinois, Iowa, Chile; Europe, Asia, Australasia. Mr. Hagelstein reports it as abundant on Long Island.

The sporangia are very small, but beautiful, delicate little structures, found mainly on bark in this country; in Norway it seems to have been seen first on a dead polyporus. Its minuteness doubtless causes it to be generally overlooked.

The var. *imperatoria* Emoto (Bot. Mag. 43 : 172, 1929) is somewhat more robust, with spores 10  $\mu$  in diameter, and with strongly netted plates.

### 5. *Barbeyella Meylan*

Bull. Soc. Bot. Genève 2 ser. 6 : 89. 1914.

Sporangia subglobose, stalked, the walls dehiscing into somewhat persistent lobes; capillitium consisting of a few simple dark threads radiating from the summit of the columella.

### BARBEYELLA MINUTISSIMA *Meylan*

Bull. Soc. Bot. Geneve 2 ser. 6 : 89. 1914.

Pl. XVI, Figs. 395, 396.

Sporangia scattered, stalked, subglobose, 0.15 to 0.2 mm. in diameter; sporangium wall membranous, dark purplish brown, dehiscing by breaking up into a few irregular lobes and plates; stalk black, subulate, solid above, tubular and enclosing refuse matter below, 0.2 to 0.6 mm. tall; columella black, about half the height of the sporangium, cylindrical or thickened at the summit; capillitium of 7 to 10 dark, simple or rarely forked threads radiating from the top of the columella and adhering by their tips to the sporangium wall; spores pale purplish gray covered with rather sparse, dark, coarse warts, 7–9  $\mu$ , sometimes nearly smooth.

Our specimens, received through the courtesy of M. Meylan, have rough spores uniformly 8.5 to 9.2  $\mu$  in diameter. The details of the dehiscence are described by Jarocki (1931).

Known only from the Jura Mountains of Switzerland, from Poland, in the latter country occurring both in the Carpathians and in the lowlands, and from Japan.



6. *Lamproderma* Rost.

Versuch 7. 1873.

Sporangia stipitate, rarely sessile, globose or ellipsoid; columella cylindric or sometimes clavate, scarcely attaining half the height of the peridium; peridium shining with metallic tints, deciduous, except where, at the base of the columella, it forms a ring around the stipe; capillitium rising in tufts or by simple branches mainly from the tip of the columella, the threads regularly forked, generally united into a net.

The lamprodermas are distinguished from the comatrichas, to which they are most nearly allied, by the arrangement of the capillitium, its development largely from the apex of the columella, the continuation of the stipe within the peridium. In other words, the peridium leaves the stipe some distance below the point where the lowest capillitial branches take origin. In mature specimens the peridium has often entirely disappeared, its only trace a more or less distinct collar around the stipe marking the beginning of the columella. Nevertheless the peridium is far more persistent than in any comatricha, and shows in yet greater brilliancy the wondrous metallic tints and iridescence of *Comatricha* and *Diachea*. Older authors, so far as can be seen, distributed the species between *Physarum* and *Stemonitis*.

Meylan, who has devoted much attention to the genus and has described a number of new species, is of the opinion that many of the older names have been used to designate what are in reality aggregates of several species which must eventually be recognized. The difficulties in the way of deciding which are constant characters and which are variations induced by changes in the environment are so great, however, that it seems wise to be conservative in recognizing newly proposed forms. Meylan's species are therefore mentioned in connection with the forms within which they would seem to be included according to older usage.

KEY TO THE SPECIES OF *LAMPRODERMA*

- |  |                            |
|--|----------------------------|
| a. Spores reticulated or marked with raised bands or lines of warts.....   | b                          |
| a. Spores warted, spinulose or nearly smooth.....  | d                          |
| b. Reticulation complete, regular.....   | 1. <i>L. cribrarioides</i> |
| b. Reticulation incomplete or replaced by lines.....   | c                          |
| c. Peridium thin, membranous, dark gray; spores covered with warted vesicles, the warts in lines or circles..... | 2. <i>L. cristatum</i>     |
| c. Peridium somewhat thicker, fragile, dull; spores incompletely reticulate with lines of warts.....             | 3. <i>L. atropurum</i>     |
| d. Spores coarsely echinulate, 14-20 $\mu$ .....   | e                          |
| d. Spores finely warted or echinulate, usually under 15 $\mu$ .....  | g                          |

- e. Stalked; peridium iridescent; spores 15-20  $\mu$  . . . . . 4. *L. echinulatum*  
e. Usually sessile . . . . . f  
f. Iridescent; columella lacking; spores 18-19  $\mu$  . . . . . 5. *L. insessum*  
f. Dull; columella well developed; spores 14-16  $\mu$  . . . . . 6. *L. echinosporum*  
g. Peridium netted, silvery blue over black . . . . . 7. *L. gulielmæ*  
g. Peridium not netted . . . . . h  
h. Stipe scarcely exceeding height of sporangium, sometimes very short or lacking . . . . . i  
h. Stipe as a rule greatly exceeding height of sporangium, sometimes short . . . . . j  
i. Sessile; sporangia ovate, taller than wide; capillitium dense, dark . . . . . 8. *L. carestia*  
i. Peridium thin, iridescent; capillitium delicate, pale; spores pallid, 8-11  $\mu$  . . . . . 9. *L. violaceum*  
i. Peridium firmer, blue or bronze; capillitium coarse, appearing hoary; spores dark, mostly 10-15  $\mu$  . . . . . 10. *L. sauteri*  
j. Columella divided at tip into several primary branches of the dense capillitium . . . . . 11. *L. arcyrionema*  
j. Columella undivided; capillitium not dense, the numerous branches arising directly . . . . . k  
k. Stipe slender, smooth, thread-like; sporangia very small 12. *L. scintillans*  
k. Stipe thick, rough, stuffed; larger . . . . . l  
l. Columella swollen, obtuse; capillitium simple, rigid . . . 13. *L. physaroides*  
l. Columella slender, tapering; capillitium branching freely . . . . . 14. *L. columbinum*

## 1. LAMPRODERMA CRIBRARIOIDES (Fr.) R. E. Fries

Svensk. Bot. Tidssk. 4 : 259. 1910.

Pl. XIII, Figs. 309, 310.

1829. *Stemonitis cribrarioides* Fr., Syst. Myc. 3 : 163.1888. *Lamproderma lycopodii* Raunk., Bot. Tidsskr. 17 : 90.

Sporangia scattered or clustered, globose, 0.8-1 mm. in diameter, sessile or occasionally with very short stalks, rarely plasmodiocarpous, purple-brown, iridescent; sporangium wall membranous, colorless above, purplish brown below; stalk, when present, black, often flattened or membranous, 0.1 to 0.6 mm. high; columella cylindrical, penetrating the sporangium to half or two-thirds of its height, absent in the plasmodiocarpous form; capillitium a network of pale purplish brown flexuose threads which are stouter below, slender and colorless at the tips; spores dark purplish brown, 11-16  $\mu$  in diameter, regularly reticulated with narrow raised bands that form a net with from 8 to 24 meshes to the hemisphere and that show as a border 0.5 to 1.5  $\mu$  wide.

The dark, reticulate spores are characteristic. Miss Lister says they are from 11 to 18  $\mu$  in diameter, a very wide range; Raunkiaer says 12-18  $\mu$ , Meylan 11-14  $\mu$ . In material collected by Seaver and Shope in Colorado, the sporangia are rather densely clustered and the spores

are very uniformly 14–16  $\mu$ . In a collection from Rumania they are even more uniform in size, almost all falling between 14.4 and 15.2  $\mu$ . Colorado; Europe. Mainly Alpine.

2. *LAMPRODERMA CRISTATUM* Meylan

Bull. Soc. Vaud. Sc. Nat. 53 : 457. 1921.

Pl. XIII, Fig. 311.

Sporangia spherical, sessile or with a very short stalk, 1–1.5 mm. in diameter; peridium thin, membranous, dark gray, early disappearing; capillitium rather pale, gray or purplish; spores globose, dark purplish, the surface covered with vesicular, warted crests, appearing more or less reticulate under the lower powers of the microscope, 12–15  $\mu$ .

The spores are unlike those of any other slime mold. Those of our material, sent by M. Meylan, have the crests smaller and more densely aggregated than suggested by his illustration or that of Miss Lister, pl. 216, h, and measuring 14–15  $\mu$ .

Switzerland.

3. *LAMPRODERMA ATROSPORUM* Meylan

Bull. Soc. Vaud. Sc. Nat. 46 : 51. 1910.

Pl. XIII, Figs. 312, 313.

Sporangia sessile or stalked, globose or oval, 1–1.3 mm. in diameter; stalks, when present, not exceeding height of sporangia; peridium fragile, not membranous, fugacious, breaking up into small fragments some of which adhere to the capillitium, rarely membranous and persistent at base, very dark with silvery sheen; capillitium black or very dark brown, showing no trace of violet; columella slender, exceeding the middle; spores dark, strongly warted, the warts arranged in reticulate lines over a portion of the surface of most of the spores, 11–15  $\mu$ . Plasmodium black.

There is wide variation in the spore markings, ranging from a nearly complete reticulation to a mere trace.

G. Lister and Howard (Jour. Bot. 57 : 25, 27, 1919) describe from England the varieties *debile* and *anglicum*, paler in color.

Oregon; Switzerland, England.

4. *LAMPRODERMA ECHINULATUM* (Berk.) Rost.

Mon. App. 25. 1876.

1860. *Stemonitis echinulata* Berk., in Hooker, Fl. Tasm. 2 : 268.

1892. *Lamproderma listeri* Massee, Mon. 97.

Sporangia loosely clustered, globose, stalked, 0.5–1 mm. in diameter, 2–4 mm. tall, shining, with steel-blue or green reflections; wall mem-

branous, persistent; stalk subulate or cylindrical, black, rising from a well-developed hypothallus; columella cylindrical, obtuse, about half the height of the sporangium; capillitium ranging from black to colorless, arising chiefly from the upper part of the columella; threads stout, sparingly forked, colorless and slender at the tips; spores dark, strongly echinulate, 15–20  $\mu$ .

Reported from Europe and Australasia.

5. *LAMPRODERMA INSESSUM* G. List.

Trans. Brit. Myc. Soc. 4 : 41. 1912.

Sporangia sessile, clustered, iridescent purple, subglobose or forming short plasmodiocarps, 0.8 mm. in diameter; wall membranous, pale purple; columella lacking; capillitium a scanty, loose network of broad purplish threads, often expanded at the angles and marked with a few bead-like thickenings; spores dark brownish purple, closely spinulose, 18–19  $\mu$ .

Meylan has found in Switzerland a similar form, but with smaller spores, which he thinks is an abnormal development of *L. columbinum*. Otherwise known only from a single collection. If verified, *L. insessum* might well be transferred to *Diacheopsis*.

Scotland.

6. *LAMPRODERMA ECHINOSPORUM* Meylan

Bull. Soc. Vaud. Sc. Nat. 55 : 241. 1924.

Sporangia globose or ovoid, attaining 1 mm. in diameter, sessile or rarely stalked, dark grayish brown, dull; peridium persistent, membranous, somewhat furrowed; columella reaching half to three-quarters the height of the sporangium; capillitium dark violaceous brown; spores purple-black, covered with pointed or obtuse spines 1  $\mu$  long, 14–16  $\mu$  in diameter.

The large, dark, spiny spores suggest those of *L. echinulatum*, from which the present species is separated by its dull colors and sessile habit. Meylan regards it as nearly related to *L. atrosporum*, from which it differs in its brown persistent peridium, the suggestion of violet in the capillitium, and its larger, strongly spiny, but not reticulate spores.

Switzerland.

7. *LAMPRODERMA GULIELMÆ* Meylan

Bull. Soc. Vaud. Sc. Nat. 52 : 449. 1919.

Pl. XIII, Figs. 314, 315.

Sporangia stipitate, spherical, 0.5 mm. in diameter or less, silvery blue with black depressed spots; stalk slender, subulate, black, 1–



1.2 mm. in length; columella reaching half way to the summit and giving rise to the pallid or hyaline, branching columella; spores dark purple, strongly spinulose, 12–15  $\mu$ .

A very distinct species, the sporangia when full of spores marked by a network of silvery blue over black. The nearly transparent wall often remains in large part after spore discharge. We have seen no American examples.

Rare: Colorado, acc. to Lister; Europe.

#### 8. *LAMPRODERMA CARESTIÆ* (Ces. & de Not.) Meylan

Bull. Soc. Vaud. Sc. Nat. 57 : 368. 1932.

Pl. XIII, Figs. 316, 317.

1879. *Stemonitis carestiae* Ces. & de Not., Erb. Crit. Ital. No. 888.

1894. *Lamproderma violaceum* Rost. var. *carestiae* List., Mycetoza 130.

1917. *Lamproderma sauteri* Rost. var. *carestiae* Meylan, Bull. Soc. Vaud. Sc. Nat. 51 : 264.

Sporangia sessile, ovate, smaller above,  $1\frac{1}{2}$ –2 times as tall as broad, violet-blue with shining metallic tints above; columella cylindrical, about half the height of the sporangium; capillitium dense, dark; spores papillate, 11–14  $\mu$ .

Distinguished from *L. sauteri* by the elongated, sessile sporangia, the dense dark capillitium and the paler spores which average somewhat smaller.

Europe.

#### 9. *LAMPRODERMA VIOLACEUM* (Fr.) Rost.

Vers. 7. 1873.

Pl. XIII, Figs. 318, 319.

1829. *Stemonitis violacea* Fr., Syst. Myc. 3 : 162, *non* Roth 1788, *nec* Schum. 1803.

1882. *Lamproderma nigrescens* Sacc., Michelia 2 : 262, *non* Rost.

1892. *Lamproderma saccardianum* Massee, Mon. 101.

1892. *Tilmadoche berkeleyi* Massee, Mon. 332.

Sporangia closely gregarious or scattered, depressed-globose, more or less umbilicate below, metallic blue or purple, sessile or short-stipitate, 0.3–1 mm. in diameter; stipe usually rather stout, dark brown or black, even; hypothallus, when the sporangia are crowded, a thin, continuous, purplish membrane, when the sporangia are scattered, discoidal; columella cylindric or tapering slightly upward, the apex obtuse, black, attaining the center of the sporangium; capillitium lax and flaccid, made up of flexuous threads branching and anastomosing to form a network, open in the interior, more dense

without, the threads at first pale brown as they leave the columella, becoming paler outward to the colorless tips; spores minutely warted, violaceous gray, 8–11  $\mu$ .

This is our most common species; found on decaying sticks and logs late in the fall. Its pale capillitium will usually distinguish it, especially where the sporangia are empty; then the pallid free extremities of the capillitial branches give to the little spheres under the lens a white or hoary appearance not seen in any other species.

The plasmodium is at first almost transparent, then amber-tinted, sending up tiny semi-transparent spheres on shining brownish stalks. As the changes approach maturity, the sporangia become jet-black, and only at last when the spores are ready for dispersal does the peridium assume its rich metallic purple tints. Colonies a meter in length, two or three decimeters in width, are sometimes seen!

*Lamproderma arcyrioides* (Somm.) Rost., based on *Stemonitis arcyrioides* Somm. (1827), is said to be this species on the basis of a re-examination of Sommerfelt's type material. Fries and Rostafinski regarded them as distinct. The name used here has been generally accepted, and is for the present retained, as suggested in the English monograph.

Common in the northern hemisphere. Also Tasmania.

*Lamproderma fuscatum* Meylan (Bull. Soc. Vaud. Sc. Nat. 57 : 372, 1932), reported from Switzerland, seems very close to this species. The description is as follows: Sporangia stalked, globose, 1 mm. in diameter; peridium gray, with bluish or brownish reflections, fragile, breaking up into fragments; stipe shorter than the sporangium; capillitium dense, grayish brown; spores dark ferruginous in mass, pale by transmitted light, papillate, 9–11  $\mu$ . Plasmodium unknown.

#### 10. LAMPRODERMA SAUTERI Rost.

Mon. 205. 1875.

Pl. XIII, Figs. 320, 321.

1892. *Lamproderma robusta* Ellis & Everh., in Masee, Mon. 99.

1894. *Lamproderma violaceum* (Fr.) Rost. var. *sauteri* List., Mycetozoa 129.

Sporangia globose or slightly depressed, usually flattened or umbilicate below, 1–2 mm. in diameter, stipitate, stipe usually short, rarely exceeding the height of the sporangium; peridium membranous, persistent, dark blue, not brilliant; capillitium purplish, coarse, with pale tips, appearing hoary after the spores are shed; spores dark purplish brown, spinulose, 12–15  $\mu$ .

A large, dark species, varying considerably in shape of sporangium

and in color. We here include American collections formerly referred to *L. robustum* (*L. sauteri* var. *robustum* Graff, Mycologia 20 : 106, 1928). Differing from *L. violaceum*, of which the English monograph regards both *sauteri* and *caresiæ* as varieties, in the larger, darker and more distinctly spinulose spores, and in the much more robust sporangia. A mountain species, the plasmodium developing beneath the snow, according to Professor Meylan.

Forms with a slender stalk, slightly exceeding the height of the sporangium have been called var. *gracile* Meylan; others, in which the sporangium is top-shaped, var. *turbinatum* Meylan. The var. *pulchrum* Meylan has spores 15–18  $\mu$ , a shining, metallic peridium and a denser and darker capillitium; the var. *atro-griseum* Meylan has equally large spores but a dull, iron-gray peridium.

Colorado, Montana, Washington, Oregon, California; Europe.

The following three species, recently described by Professor Meylan, seem to belong close to *L. sauteri*. For the benefit of students, the descriptions are appended. All are known, thus far, only from Switzerland.

#### LAMPRODERMA SPLENDENS Meylan

Bull. Soc. Vaud. Sc. Nat. 57 : 44. 1929.

Sporangia stipitate, rarely sessile, subspherical, not umbilicate below, 0.8–1 mm. in diameter, dark blue or bronze, with brilliant metallic reflections, rarely violaceous cinereous or brilliant black; stipe 0.5–0.8 mm. in length; columella short, thick; capillitium of rather coarse, sparsely branched threads in the lower half, densely branching toward the surface, or sometimes densely branched throughout; spores pale, indistinctly papillate, 9–11  $\mu$ . Plasmodium white.

#### LAMPRODERMA OVOIDEUM Meylan

Bull. Soc. Vaud. Sc. Nat. 57 : 373. 1932.

Sporangia stipitate, ovate, 1.5–2 mm. in height, 1–1.5 mm. broad, dark blue, sometimes bronze, shining, especially above; stipe less than half the height of the sporangium; capillitium dense, dark brownish purple; spores dark, papillate, 13–15  $\mu$ . Plasmodium white.

The var. *piriforme* Meylan, formerly regarded by its author as a variety of *L. sauteri*, has a dark, shining, but not iridescent, peridium, an obovate sporangium and very dark spores, 15–18  $\mu$ . The var. *cucumer* Meylan is characterized by a cucumber-shaped sporangium, grayish capillitium and smaller, paler spores, 10–13  $\mu$ .

LAMPRODERMA PULCHELLUM *Meylan*

Bull. Soc. Vaud. Sc. Nat. 57 : 369. 1932.

Sporangia sessile, globose, dark violet-blue with few reflections, 0.5–1 mm. in diameter; columella short, sometimes almost lacking, attaining at most one-third the height of the sporangium; capillitium densely branched, pale rose; spores brownish purple, minutely papillose, 12–14  $\mu$ . Plasmodium unknown.

The sporangia appear in characteristic lines on the stems of grasses.

11. LAMPRODERMA ARCYRIONEMA *Rost.*

Mon. 208. 1875.

Pl. XIII, Figs. 322, 323.

1893. *Comatricha shimekiana* Macbr., Bull. Lab. Nat. Hist. Iowa 2 : 380.

Sporangia gregarious, scattered, globose, silvery gray or bronze, iridescent, erect, stipitate; stipe black, long, two-thirds to three-fourths the total height, slender, rigid; columella slender, cylindric, attaining about one-third the height of the sporangium when it breaks into the primary branches of the capillitium; capillitium exceedingly intricate, made up of slender, flexuous brown threads which frequently branch and anastomose to form an elegant round-meshed network resembling that of *Arcyria*, free ultimate branchlets not numerous; spores in mass jet-black, by transmitted light violaceous, very faintly warted, 6–8  $\mu$ .

This species is easily recognizable by its very peculiar capillitium. This, in its primary branching, resembles a comatricha. In typical forms, the columella branches at the apex only, generally into two strong divisions which then break up irregularly and anastomose in every direction. This seems to have been the form present to Rostafinski when he wrote "columella truncate." In Central American and some North American specimens, the branching is very different; the twigs leave the columella at various points almost down to the annulus, and the entire effect is dendroid. The columella is lost almost at once. A small form of this species was formerly distributed in the United States as *Comatricha friesiana* Rost. This circumstance led the senior author to describe Central American forms as *C. shimekiana*. Judging from a remark by Massee (Mon. p. 97), a similar confusion seems to have prevailed in Europe. As a matter of fact, the resemblance between *C. friesiana* (i. e., *C. nigra*), and the present species is sufficiently remote.

*Lamproderma minutum* Rostafinski may be a small form of this species. Rostafinski bases his diagnosis upon the branching of the



columella, which is, as we have seen, inconstant, and upon the colorless capillitium. This feature in specimens examined is also inconstant.

Occurring in large colonies on barkless decaying logs of various species; the plasmodium almost colorless.

Common. Canada to Nicaragua, Puerto Rico, Brazil; Europe, Asia, Africa.

12. *LAMPRODERMA SCINTILLANS* (Berk. & Br.) Morgan

Jour. Cin. Soc. Nat. Hist. 16 : 131. 1894.

Pl. XIII, Figs. 324, 325.

1877. *Stemonitis scintillans* Berk. & Br., Jour. Linn. Soc. 15 : 84.

1877. *Lamproderma arcyrroides* (Somm.) Rost. var. *iridea* Cooke, Myx. G. B. 50.

1892. *Lamproderma irideum* Massee, Mon. 95.

Sporangia gregarious, scattered, globose or depressed-globose, 0.3–0.5 mm. in diameter, metallic blue-purple or bronze, iridescent, stipitate; the stipe long, slender, even, inclined and nodding or sometimes erect; hypothallus small, circular; columella cylindric, small, not reaching the center, black; capillitium dense, of rigid, straight, sparingly branched or anastomosing brown threads, which are typically white or colorless just as they leave the columella; spores globose, rough, violaceous brown, 7–9  $\mu$ .

The capillitium is remarkable, and constitutes an easy diagnostic mark. The threads appear at first sight entirely simple, but are really several times furcate, and not infrequently anastomose. The spores are covered with sparsely sown large papillæ, easily seen under moderate magnification.

This is one of our earliest species. To be sought in May on beds of decaying oak leaves in the woods, especially in wet places, near streams, etc.

Not common in North America. Reported from New England, Pennsylvania, Ohio, Iowa, Bolivia; Rumania, Ceylon, Japan.

13. *LAMPRODERMA PHYSAROIDES* (Alb. & Schw.) Rost.

Mon. 202. 1875.

1805. *Stemonitis physaroides* Alb. & Schw., Consp. Fung. 103.

Sporangia gregarious, wide-spreading, globose, the peridium persistent with a silver metallic, sometimes brassy luster; stipe long, rather thick, brown or black, tapering upward; hypothallus well developed, brown or purple, usually not continuous; columella swollen at tip, obtuse, short at best, hardly attaining the center of the sporangium;

capillitium very rigid, of simple or sparingly branched, dark brown threads radiating from the clavate apex of the columella and only here and there anastomosing toward the surface, the ultimate divisions distinctly rough; spores lilac-brown, rough, 10–12.5  $\mu$ .

This species is well described in Rostafinski's Monograph. It is marked by its clavate columella and peculiarly simple, dark, rigid capillitium, the branches of which rise in great numbers immediately from the columella, and maintain their primitive thickness during the greater part of their length. The transverse vincula are often at right angles to the principal branches, and the meshes, where formed, are often long and rectangular. Externally, it resembles *L. arcyronema*, but is by its spores and capillitium instantly distinguished. Rostafinski gives the spore-size as 12.5–14.2  $\mu$ . Large spores are less common in the specimens before us.

In the third edition of the English monograph this species is doubtfully included in *L. columbinum*.

In the first edition of North American Slime-Moulds, this species was entered from lists published for New England, New York and Ohio. The intervening years, however, have brought no confirmation. Specimens from Maine and Ohio, with large spores, represent *L. columbinum*, and those cited from New York are forms of *L. violaceum*. It is accordingly doubtful whether *L. physaroides* occurs in North America. That it is to be found in Europe there seems no doubt. The figure and description of Schweinitz may indeed be inconclusive, but Rostafinski's citation and abundant description leave no doubt as to his opinion; while numerous localities named would indicate adequate material. What Rostafinski described will no doubt obtain wider recognition some day.

#### 14. LAMPRODERMA COLUMBINUM (Pers.) Rost.

Mon. 203. 1875.

(as *L. columbina*)

Pl. XIII, Figs. 326, 327.

1795. *Physarum columbinum* Pers., Ust. Ann. Bot. 15 : 5.

1808. *Trichia columbina* (Pers.) Poir. Lam. Encycl. 8 : 52.

1836. *Fulgia encaustica* Chev., Fl. Par. ed. 2. 347.

Sporangia scattered, gregarious, rich violet or purple with metallic iridescence, globose, stipitate; stipe long, three-fourths the total height, subulate, black; hypothallus scant, purplish or brown; columella small, one-third the height or less, tapering or acute, black; capillitium brown throughout, not dense, arising from nearly all parts of the columella, freely branching and anastomosing to an open,

large-meshed network; spore-mass black; spores by transmitted light smoky brown, rough, 11–14  $\mu$ . Plasmodium white, rarely yellow.

Rostafinski distinguished this beautiful species by the color of the peridium and the conic columella. According to Mr. Lister, Rostafinski was not sufficiently careful in labelling his material, different forms having been included under this specific name. Nevertheless, the description is well drawn, and excludes *L. physaroides* completely. At all events our American specimens correspond so well with the description of *L. columbinum* (Pers.) Rost. that there seems no doubt that we have here what the Polish author figured and described, whether or not he was always consistent in applying his labels. The color distinguishes at sight the present species from *L. physaroides*, and the capillitium and large rough brown spores distinguish it from *L. violaceum*. The capillitium of the minute *L. scintillans* is much denser and more rigid, and the spores smaller. The stipe when dry is ciliate.

This is the common species of our western mountains, especially on the Pacific slope. In the Cascades every dark ravine is certain to show it in later summer and autumn, far extended colonies covering the moist surfaces of every moldering log, the myriad globoid sporangia giving back when brought to the sunlight the most extravagant blues and greens with all the splendor of metallic sheen. Their brilliant beauty never fails to quicken the attention of even the most insensate tourist.

The English monograph recognizes the varieties *gracile* G. List., with elongated oval sporangia; *iridescens* G. List. (= *Physarum iridescens* Berk., Hooker Jour. Bot. 3 : 20, 1851; *L. iridescens* (Berk.) Rost., Mon. App. 25, 1876), with spherical sporangia and pale, lax capillitium, and *brevipes* G. List., with dull, flattened sporangia and very short stalks. Meylan (Bull. Soc. Vaud. Sc. Nat. 56 : 322, 1927) believes *brevipes* a distinct species, and in the same publication raises his former variety *subglobosum* to specific rank as *L. subglobosum*. This has a slightly flattened sporangium, like *brevipes*, but a long stalk and a short columella. *L. cruchetii* Meylan is not regarded by Miss Lister as worthy even of varietal recognition. According to Meylan it has a yellow plasmodium requiring two or three weeks to form sporangia, while that of *L. columbinum* is white and forms sporangia in two to four days after emergence. There are other differences cited, such as the proportionately shorter stem of *cruchetii*, its somewhat simpler capillitium, and its somewhat larger, often greenish brown spores. These forms are as yet known only from the Swiss mountains, but will doubtless appear elsewhere.

Abundant in the western forests, extremely rare in the eastern

United States. British Columbia, Washington, Oregon, Montana, Maine, Pennsylvania, South Carolina; Europe, Tasmania.

## ORDER LICEALES

True capillitium none or rarely scantily developed (except in genus *Alwisia*); pseudocapillitium present or absent, when present, of tubules or perforated plates which sometimes fray out into threads; spores pallid or brown, rarely dark.

## KEY TO FAMILIES OF LICEALES

- a.* Sporangium wall membranous, often falling away between net-like thickenings; sporangium and spores dotted with plasmodic granules. . . . . CRIBRARIACEÆ
- a.* Sporangial wall not netted; plasmodic granules lacking. . . . . *b*
  - b.* Sporangia separate, sometimes more or less plasmodiocarpous. . . . . LICEACEÆ
  - b.* Sporangia densely massed, usually forming a pseudo-æthalam; or fructification a true æthalam. . . . . *c*
- c.* Sporangia closely appressed, but with walls entire; individual sporangia dehiscent at apex. . . . . TUBIFERACEÆ
- c.* Fructification either a true æthalam or a pseudo-æthalam in which the sporangial walls disappear at maturity; dehiscence typically irregular. . . . . *d*
  - d.* Pseudocapillitium thread-like or of perforated, frayed or fragmentary plates; spores ochraceous or umber. . . . . RETICULARIACEÆ
  - d.* Pseudocapillitium of colorless branched tubes; spores pinkish or pallid. . . . . LYCOGALACEÆ

## FAMILY CRIBRARIACEÆ

Sporangium wall membranous, dotted with microscopic plasmodic granules; continuous or more typically with net-like thickenings in the upper portion, the remainder fugacious; capillitium entirely absent.

The distinctive character of this family is to be found in conspicuous dark granules found both in the plasmodium and in the fructifications. The place of capillitium is taken, except in *Lindbladia*, by the net-like thickenings of the peridium wall, left when the thinner portions of the wall disappear, and serving to hold the spherical central mass of spores while permitting their gradual liberation. The plasmodium is often brilliantly colored—violet, purple, blue, green, brown or black. The species occur more commonly on coniferous wood.

## KEY TO THE GENERA OF THE CRIBRARIACEÆ

- a.* Æthalioid, the net lacking. . . . . 1. *Lindbladia*
- a.* Sporangia separate, stalked or very rarely sessile; net present. . . . . *b*
  - b.* Main threads of net short, connected by numerous expanded nodes. . . . . 2. *Cribraria*
  - b.* Main threads of net parallel, extending from base to apex, connected by delicate filaments. . . . . 3. *Dictydium*



1. *Lindbladia* Fries

Summa Veg. Scand. 449. 1849.

Fructification æthalioid; the sporangia short, tubular, sometimes superimposed, sometimes forming a simple stratum, in the latter case generally sessile, but sometimes short-stipitate, the peridium at first entire, at length opening irregularly either at the sides or apex, beset with granules; spores olivaceous.

This genus was established by Fries in 1849 to accommodate a single species of wide distribution and somewhat varying habit, which is neither a tubifera nor yet a cribraria but offers points of resemblance to each. It resembles *Tubifera* in its simple sporangia, opening without the aid of a net; it is like certain species of *Cribraria* in the smooth ochraceous-olivaceous spores and is allied to that genus by its granuliferous peridium.

## LINDBLADIA EFFUSA (Ehr.) Rost.

Mon. 223. 1875.

Pl. XIII, Figs. 328, 329.

1818. *Licea effusa* Ehr., Sylv. Myc. Ber. 26.1849. *Lindbladia tubulina* Fr., Summ. Veg. Scand. 449.1851. *Æthaliium atrum* Preuss, Linnæa 24 : 141.1854. *Reticularia maxima* Corda, Icon. 6 : 14, pl. 2, fig. 35.1892. *Tubulina effusa* (Ehr.) Massee, Mon. 41.

Sporangia minute, either closely combined and superimposed, so as to form a pulvinate æthaliium, or crowded together in a single layer, sessile or short-stipitate; the peridia thin, membranous, marked by scattered plasmodic granules, often lustrous, sometimes dull lead colored or blackish, especially above; stipe, when present, very short but distinct, brown, rugulose; hypothallus well developed, membranous, or more or less spongy in structure; spore-mass ochraceous; spores under the lens nearly smooth, almost colorless, 6–7.5  $\mu$ . Plasmodium brownish black.

This very variable species has been well studied by Dr. Rex. See Bot. Gaz. 17 : 201. In its simpler phases it presents but a single layer of sporangia generally closely crowded together, sometimes free and even short-stipitate! In the more complex phase the sporangia are heaped together in a pulvinate mass in which the peridia appear as boundaries of minute cells. In this case the outermost sporangia are often consolidated to form a cortex more or less dense and shining. In any case the hypothallus is a prominent feature; generally laminated and of two or three layers, it is in the more hemispheric æthalia

very much more complex, sponge-like. When thin this structure is remarkable for its wide extent, 40–50 cm.! The simpler forms approach very near to *Cribraria* through *C. argillacea*. The most complex remind us of *Enteridium*.

Var. *simplex* Rex, Bot. Gazette 17 : 202, 1892 (= *Licea spermoides* Berk. & Curt., Grev. 2 : 68, 1873; *Physarum caespitosum* Peck, Rept. N. Y. Mus. 26 : 75, 1874; *Perichæna caespitosa* Peck, Rept. N. Y. Mus. 31 : 57, 1889; *Tubulina spermoides* (B. & C.) Massee, Mon. 37, 1892; *Tubulina caespitosa* (Peck) Massee, Mon. 43, 1892) is sometimes used for the phase in which the sporangia are more or less separate, cylindrical, even stalked, approaching *Cribraria argillacea*.

Ehrenberg throws some doubt on the species he describes by suggesting that the plasmodium may be *red*. The description, however, and figures are otherwise good. The plasmodium has much the same color as the mature fruit.

Widely distributed. New England to the Black Hills and Colorado, south to Arkansas and west to Washington and California; northern temperate regions, Ceylon.

## 2. *Cribraria Persoon* emend. *Rost.*

Mon. 231. 1875.

1794. *Cribraria* Pers., Roemer N. Mag. Bot. 1 : 91, in part.

1797. *Cribraria* Schrader, Nov. Gen. Plant. 1.

Sporangia distinct, gregarious or closely crowded, globose or obovoid, stipitate or rarely sessile; the stipe of varying length; the peridium simple, marked within by distinct and peculiar granular thickenings, which below take the form of radiating ribs, supporting the persisting cup, the calyculus, and above, by extremely delicate anastomosing branches, united to weave a more or less regular net with open polygonal meshes; spores various, most commonly yellowish or ochraceous, sometimes brown, reddish or purple.

The genus *Cribraria*, as limited by Persoon, included all forms in which the peridium is thin, evanescent at least in the upper half, and in which the capillitium, as Persoon regarded it, is formed of a network of reticulate threads surrounding the spores. Schrader redefined the genus; opposed Persoon's view as to the capillitial nature of the net, and separated the genus *Dictydium*, but by imperfect limitations,—in fact, chiefly because of the more completely evanescent peridium. Fries follows Schrader. Rostafinski first clearly separated the two genera, and his classification is here adopted. Nevertheless, after reviewing the subject one is more and more inclined to appre-

ciate the commendation of Fries: "Auctor Schrader, qui insuper plurimas species detexit, et hoc et sequens genus ita proposuit ut sequentes vix aliquid addere valuerint."

As to the habitat of the cribrarias, the remark of Schrader—"in vetustissimis plenariæ destructioni proximis arborum truncis"—is pertinent for all the species save one. Rotten coniferous wood seems to be preferred, but frondose wood is by no means refused. Rotten oak forms a not infrequent substratum.

The major part of the following key and a considerable part of the treatment of the species is based on the work of Miss Eunice Lovejoy, presented as a thesis at the University of Iowa in 1931.

#### KEY TO THE SPECIES OF CRIBRARIA

- a. Net obscure, fugacious; sporangia sessile or short-stipitate; densely crowded. . . . . 1. *C. argillacea*
- a. Net persistent; sporangia stalked; gregarious or scattered. . . . . b
  - b. Ochraceous or brown. . . . . c
  - b. Orange, red or purple. . . . . q
- c. Calyculus lacking, or, if present, very small or represented by ribs. (See also Nos. 6, 14) . . . . . d
- c. Calyculus well developed. (See also Nos. 4, 5) . . . . . g
  - d. Free ends lacking in net, or few. . . . . e
  - d. Free ends usually numerous. . . . . f
- e. Moderately large, 0.3–0.7 mm. in diameter; nodes flattened. . . . . 2. *C. splendens*
- e. Small, under 0.4 mm. in diameter; nodes thickened. . . . . 3. *C. microcarpa*
  - f. Connecting threads of net single; granules ochraceous. . . . . 4. *C. dictydioides*
  - f. Connecting threads often parallel in twos or threes; granules dark brown. . . . . 5. *C. intricata*
- g. Nodes expanded. . . . . h
- g. Nodes thickened. . . . . i
  - h. Net light ochraceous, meshes small, with no free ends. . . . . 6. *C. minutissima*
  - h. Net dark brown, meshes large, with free ends. . . . . 7. *C. atrofusca*
- i. Nodes flat and angular. . . . . j
- i. Nodes rounded. . . . . o
  - j. Sporangia small, under 0.4 mm. . . . . k
  - j. Sporangia larger, over 0.5 mm. . . . . m
- k. Copper colored; meshes large; nodular granules pale. . . . . 8. *C. cuprea*
- k. Dark brown, with dark granules. . . . . l
  - l. Deep reddish brown; spores 5–6.5  $\mu$ . . . . . 9. *C. languescens*
  - l. Nearly black; spores 9  $\mu$ . . . . . 10. *C. oregana*
- m. Spores reticulated. . . . . 11. *C. dictyospora*
- m. Spores spiny or roughened. . . . . n
  - n. Dusky; margin of calyculus dentate; free ends few. . . . . 12. *C. piriformis*
  - n. Yellow-brown; margin of calyculus perforated; free ends numerous. . . . . 13. *C. macrocarpa*

- o.* Small, under 0.5 mm. in diameter; stipe 2–6 mm. . . . . 14. *C. tenella*  
*o.* Larger, 0.5 mm. or over; stipe 1–2 mm. . . . . *p*  
*p.* Yellow-brown; margin of calyculus dentate; on wood. . . 15. *C. aurantiaca*  
*p.* Nut brown; calyculus prominently ribbed; on leaves. . . 16. *C. laxa*  
*q.* Deep yellow, orange or red. . . . . *r*  
*q.* Purple, lavender or blue. . . . . *t*  
*r.* Reddish tawny; minute, 0.15–0.2 mm. in diameter. . . . 17. *C. exigua*  
*r.* Deep yellow or orange; diameter 0.6–0.7 mm. . . . . 18. *C. rufa*  
*r.* Red; over 1 mm. in diameter. . . . . *s*  
*s.* Ruby red; nodes expanded, not granular. . . . . 19. *C. rubiginosa*  
*s.* Brick-red; nodes scarcely expanded, granular. . . . . 20. *C. ferruginea*  
*t.* Nodes expanded. . . . . *u*  
*t.* Nodes thickened. . . . . *v*  
*u.* Net purple; nodular granules reddish purple. . . . . 21. *C. purpurea*  
*u.* Net dark blue; nodular granules black. . . . . 22. *C. lepida*  
*v.* Deep lilac or reddish purple, 0.4–0.5 mm. in diameter;  
spores 5–6  $\mu$ . . . . . 23. *C. elegans*  
*v.* Violet, 0.2–0.3 mm. in diameter; spores 7–8  $\mu$ . . . . . 24. *C. violacea*

# 1. CRIBRARIA ARGILLACEA Pers.

Roemer N. Mag. Bot. 1 : 91. 1794.

Pl. XIII, Figs. 330, 331.

1791. *Stemonitis argillacea* Pers., in Gmel., Syst. Nat. 2 : 1469.

1797. *Cribraria micropus* Schrad., Nov. Gen. Pl. 3, pl. 2, figs. 1, 2.

1808. *Trichia argillacea* (Pers.) Poiret, in Lam. Encycl. 8 : 55.

Sporangia dull ochraceous-olivaceous, globose, nearly 1 mm. in diameter, sessile or short-stipitate, closely gregarious or crowded, the peridial walls at maturity smooth, shining, except above, long-persistent, obscurely reticulate, with irregular thickenings which at the apex at length present the appearance of an irregular, coarsely meshed net without nodal thickenings; hypothallus silvery, evanescent; stipe, when present, very short, stout, erect, reddish brown; spore-mass ochraceous; spores by transmitted light pale yellow, spinulose, 5–7  $\mu$ . Plasmodium lead colored, scanty.

In habit and form of sporangia suggesting Tubifera, but possessing the reticulations and plasmodic granules of Cribraria. In freshly formed sporangia the reticulations are barely visible in the crown; later on they are more manifest, until, as spore dispersal proceeds, the cribraria characters come out with sufficient distinctness, and in empty sporangia the reticulations may be seen to affect the entire peridial wall. The nodes are not expanded.

Not uncommon. New England, Ontario and Washington to South Carolina, Iowa and Oregon. Widely distributed in temperate regions, mainly on rotten coniferous wood; also reported from South Africa.



2. CRIBRARIA SPLENDENS (*Schrad.*) *Pers.*

Syn. Meth. Fung. 191. 1801.

Pl. XIV, Figs. 332, 333.

1797. *Dictydium splendens* Schrad., Nov. Gen. Pl. 14, pl. 4, figs. 5, 6.1808. *Trichia splendens* (Schrad.) Poir., in Lam. Encycl. 8 : 55.

Sporangia gregarious, globose, 0.3–0.7 mm. in diameter, yellow when filled with spores, dull or dusky brown when these are discharged, stipitate; stipe long, 3–4 times the sporangium, subulate, erect-nodding, brown; hypothallus small; network brown, with large meshes, imperfectly defined, flattened nodes and flattened threads; calyculus none, its place supplied by nine or ten distinct, firm ribs which radiate from the stipe and support the net, branching to blend with its reticulations; spore-mass yellow; spores by transmitted light colorless, smooth or nearly so, 6–7  $\mu$ . Plasmodium lead colored.

Differing from all other species in the peculiar ribs which take the place of the calyculus. The color is a glistening yellow or brown. The stipe displays a purple iridescence in bright sunlight; in duller light it appears purplish brown.

Widely distributed, but rare. Nova Scotia, Ontario, New York, Pennsylvania, Iowa, Wyoming, Washington, West Indies; Europe, Malay Peninsula, Japan.

3. CRIBRARIA MICROCARPA (*Schrad.*) *Pers.*

Syn. Meth. Fung. 190. 1801.

Pl. XIV, Figs. 334, 335, 336.

1797. *Dictydium microcarpum* Schrad., Nov. Gen. Pl. 13, pl. 4, figs. 3, 4.1808. *Trichia microcarpa* (Schrad.) Poiret, in Lam. Encycl. 8 : 54.

Sporangia scattered, yellow ochraceous, globose, stipitate, nodding, 0.15–0.4 mm. in diameter; calyculus none, net arising directly from the stipe, the meshes large, mostly rectangular, a few triangular; nodes thickened, rounded, small, dark brown, granular; connecting threads stout, transparent, free ends few or none; stipe dark purplish brown, 0.5–1.5 mm. long, furrowed, slender, tapering upward; spore-mass yellow, fading to ochraceous; spores by transmitted light pale, minutely spinulose, 6–7  $\mu$ . Plasmodium purplish black according to Lister; in our experience colorless except as colored by material from the substratum.

At first sight resembling *C. tenella*, but the sporangia are smaller, the meshes of the net larger, the nodes smaller and fewer in number, the stipe shorter, the calyculus lacking and the ribs few and simple. In the Lister monograph the color is given as purplish red with the

spores pale red in mass. Schrader's original description calls for a brown form with yellow spores, which is in agreement with the specimens examined. The entire fructification becomes purple, however, when mounted in potassium hydroxide.

Not common. New England, Ontario, Pennsylvania, Ohio, Iowa, Missouri, California; Europe, southern Asia, Japan.

#### 4. CRIBRARIA DICTYDIOIDES *Cooke & Balf.*

in Masec, Mon. 65. 1892.

Pl. XIV, Figs. 340, 341, 342.

1894. *Cribraria intricata* Schrad., var. *dictydioides* (Cke. & Balf.) List., Mycetozoa 144.

Sporangia gregarious, dusky brown, globose, 0.5–0.7 mm. in diameter, cernuous, stipitate; stipe long, slender, furrowed, tapering upwards, dull brown in color; hypothallus small; calyculus rudimentary or represented only by irregular, node-like ribs; network delicate, the meshes small, few-sided; nodules large, prominent, brown, irregular, with several radiating, free, projecting threads, beside the single continuous filaments which pass from node to node; spore-mass pale, ochraceous; spores nearly smooth, colorless, 5–7  $\mu$ .

This seems to be the most common *Cribraria* in the Mississippi valley. It is generally distinguished by the lack of a calyculus and the beautiful richness of its clear delicate net. The stellate nodules, especially above, emit rays in all directions, but are, notwithstanding, united by single, unpaired threads only. The rather large sporangia, the nodes joined by single threads, the remaining radiant threads, many or few, but very short—these seem to be the most distinctly diagnostic characters, and these are sufficiently constant to separate this species easily from *C. intricata* on the one hand and *C. tenella* on the other.

Abundant on rotten logs of every sort, especially oak. New York and Ontario to Wisconsin, North Carolina and Nebraska, Washington; Europe, West Africa, southern and eastern Asia.

#### 5. CRIBRARIA INTRICATA *Schrad.*

Nov. Gen. Pl. 7, pl. 3, fig. 1. 1797.

Pl. XIV, Figs. 337, 338, 339.

1808. *Trichia intricata* (Schrad.) Poiret, in Lam. Encycl. 8 : 56.

Sporangia gregarious, globose, large, 0.6–1 mm. in diameter, nut-brown or olivaceous, erect or nodding, stipitate; stipe long, 1.5–3 mm.,

dark brown, furrowed, slender, flexuous, tapering upward; calyculus lacking, its place taken by reddish brown, granular ribs; net prominent, meshes of medium size, usually triangular; nodes thickened, large, irregular, reddish brown, granular, giving rise to many long free ends; connecting threads parallel, often two or three together; hypothallus conspicuous; spores ochraceous in mass, by transmitted light pale, spiny, 6-7  $\mu$ .

Distinguished by the parallel connecting threads, agreeing in this respect with Rostafinski's fig. 27, pl. 2, and Masee's fig. 11, pl. 1. Lister regards *C. dictydioides* as merely a variety of this species. The latter, however, has short free ends and nodes of a lighter color. *C. tenella* also resembles it in shape and size of the sporangium but is provided with a calyculus and lacks the long free ends and parallel connecting threads.

Rare. New England, Pennsylvania, Iowa, Missouri, West Indies, Bolivia; Europe, South Africa, Ceylon, Malay Peninsula, Japan.

#### 6. CRIBRARIA MINUTISSIMA Schw.

Trans. Am. Phil. Soc. II. 4 : 260. 1832.

Pl. XIV, Figs. 343, 344, 345.

1873. *Cribraria minima* Berk. & Curt., Grev. 2 : 67.

1873. *Cribraria microscopica* Berk. & Curt., Grev. 2 : 67.

Sporangia minute, scattered, nut-brown, 0.1-0.3 mm. in diameter, erect; calyculus variable, when fully mature separated from the net by a shallow constriction; more commonly the constriction is not present, and the cup may be entirely lacking; nodes expanded but not thickened, bearing light granules; connecting threads flattened, free ends lacking, hypothallus none; stipe brown, one to three times the height of the sporangium; spore-mass yellow; spores by transmitted light pallid, minutely roughened, 5-7  $\mu$ .

In its typical expression this species is characterized by its minute size and the wide-meshed net bulging from the calyculus. Often, however, the calyculus is partly or entirely suppressed. The sporangia without calyculus, however, are usually scattered among others with it, and are often smaller, suggesting incomplete development. They have every appearance of having arisen from the same plasmodium. *C. minima* and *C. microscopica* seem to stand for these forms with and without the calyculus, respectively.

Rare, or at least seldom collected. New York, Pennsylvania, North Carolina, South Carolina, Missouri, Iowa, South Dakota, Washington; Europe, southern Asia.

7. CRIBRARIA ATROFUSCA *Martin & Lovejoy*

Jour. Wash. Acad. Sc. 22 : 92. 1932.

Pl. XV, Figs. 368, 369, 370.

Sporangia loosely gregarious, dark purplish brown to nearly black, shining, iridescent, globose or somewhat obovate or occasionally pyriform, usually erect, 0.4–0.6 mm. in diameter, total height 1–2 mm. or more; calyculus occupying nearly or quite one-half of spore-case, marked by slender granular ribs radiating from the stipe and by broken concentric granular thickenings deposited on the inside, the concentric character being visible without under the lens in brilliant light, the margin with very fine teeth and long, slender tooth-like projections which bear the net and are similar to its nodes; net regular, with broad connecting threads, the nodes expanded, granular, dark brown, with a few free ends arising from both nodes and threads, the silvery peridium tending to persist; hypothallus small; stipe dark brown or nearly black, slender, furrowed, 0.6–1.8 mm. long; spores dark reddish brown in mass, grayish brown by transmitted light, finally verrucose, 7.5–8.1  $\mu$ , averaging 7.9  $\mu$ .

A distinct species. The dark glistening sporangium, the dark spores, and the granular concentric rings within the calyculus are diagnostic. The tooth-like projections which bear the net are longer and more slender than in any other species, but their structure suggests that they are to be regarded as elements of the net rather than of the calyculus. The peridium tends to be more persistent than in most *cribrarias* and in its shining silvery character suggests *Lamproderma arcyronema*. The spores are much the color of those of the more ferruginous species of *Stemonitis*.

Colorado.

8. CRIBRARIA CUPREA *Morgan*

Jour. Cin. Soc. Nat. Hist. 15 : 142. 1893.

Pl. XIV, Figs. 346, 347.

1925. *Cribraria languescens* Rex ex Lister, *Mycetozoa* ed. 3. 176, in part.

Sporangia gregarious, small, 0.3–0.4 mm., subglobose, copper colored, stipitate, nodding; stipe concolorous or darker below, subulate, curved at the apex, 2–4 times the diameter of sporangium; calyculus one-third to one-half the sporangium, finely ribbed and granular within, the margin nearly even; net rather rudimentary, the meshes large, triangular or quadrilateral, the nodes also large, flat, concolorous, thickened, the threads slender, transparent, with few free ends; spores in mass copper colored, by transmitted light colorless, minutely roughened, 6–7  $\mu$ .



Recognizable by its small size, deep calyculus and peculiar color, that of bright copper, although this fades somewhat with age, and the metallic tints are then lacking. Related to *C. languescens* and in specimens having globular sporangia closely resembling it; but the ground color in *C. languescens* is always darker, and in well-developed specimens the stipe proportionally much longer. In habit the sporangia are widely scattered, much more than is common in the species of this genus. If one may judge from the material at hand, the favorite habitat is very rotten basswood, *Tilia americana*.

Rare. Pennsylvania, Ohio, Iowa, Missouri, Wyoming, Washington.

#### 9. CRIBRARIA LANGUESCENS *Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 394.

Sporangia scattered, very minute, 0.25–0.35 mm. in diameter, spherical, long-stipitate, drooping; stipe 2.5–3 mm., slender, flexuose, subulate, rugulose; calyculus about one-third the sporangium, reddish brown, shining, minutely striate with granular lines, the margin more or less regularly serrate; net reddish brown, the meshes triangular and the threads simple, slender; nodes large, thickened, polygonal, flat, but well differentiated; spores when fresh dull red in mass, paling with age, by transmitted light pale, nearly smooth, 6–7  $\mu$ .

A very singular species, easily recognizable by its long, very flexuose, slender stipes, terminating in exceedingly small spherical sporangia. The colors are obscure, but the striations on the calyculus are violet tinted, and reddish lavender perhaps predominates elsewhere. "In its scattered and solitary growth, its tall slender stipes and relaxed habit, it resembles *C. microcarpa*, in its network it approaches *C. tenella*, and its spores have color of the paler form of *C. purpurea*." So Dr. Rex, l. c. Western forms of the first-named species have much shorter stipes; the network in the specimens before us is unlike that of *C. tenella*, but resembles that of *C. purpurea*. *C. languescens* resembles *C. cuprea* in the shape of the sporangium and the nodes, but the colors are different, the stipe is longer and the calyculus smaller.

*C. lepida* Meylan (Bull. Soc. Vaud. Sc. Nat. 56 : 326, 1927) is similar in form, but dark violet in color, in this respect resembling *C. violacea*. While *C. languescens* commonly displays violaceous shades, no collections approach the color of *C. lepida*, which may be regarded as distinct.

Rare, but widely distributed. New York, South Carolina, Ontario, Ohio, Washington, West Indies; Europe, West Africa, Ceylon.

10. CRIBRARIA OREGANA *Gilbert*

Am. Jour. Bot. 19 : 142. 1932.

Pl. XIV, Figs. 348, 349.

Sporangia gregarious, dark brown, nearly black, small, 0.3–0.4 mm. in diameter, erect; calyculus nearly black, about one-half the sporangium, the margin deeply toothed, granular; net arising from the broad teeth of the margin; nodes thickened, large, flat and angular, crowded with dark granules; connecting threads fine, granular, with few free ends; hypothallus very small; stipe light brown, short, 0.5–0.7 mm., nearly smooth, tapering upward from a broad base; spores in mass dark brown, pale lilaceous by transmitted light, with a conspicuous guttule in each, minutely warted, globose or oval, the spherical 8–9  $\mu$ , the oval sometimes attaining 10  $\mu$  or more in the longer dimension.

Distinguished by the large spores and the dark color. The teeth at the margin of the calyculus are very broad, and two fine threads usually extend from each to the irregular nodes. The large granules frequently have a dark center with a paler peripheral portion.

Oregon.

11. CRIBRARIA DICTYOSPORA *Martin & Lovejoy*

Jour. Wash. Acad. Sc. 22 : 91. 1932.

Pl. XIV, Figs. 365, 366.

Sporangia gregarious, dark purplish brown, erect or slightly nodding, globose, 0.4–0.8 mm. in diameter, total height 1–2 mm.; calyculus occupying about one-third of the spore-case, marked with irregular, dark, granular rays, the margin toothed; net rather fine-meshed, the connecting threads narrow, the nodes flat and angular, not greatly thickened, densely filled with large, dark granules, making them appear black, free ends abundant, often branched, arising both from nodes and from connecting threads; stipe slender, two or three times the diameter of the sporangium, furrowed, light at the apex, otherwise dark; spores ochraceous brown in mass, clear violet by transmitted light, globose or somewhat angular, minutely warted, and under oil immersion shown to be covered with a coarse and often imperfect reticulum of three to five meshes to the hemisphere, 8–8.8  $\mu$ , averaging 8.5  $\mu$ .

The most striking characteristic of this species is the reticulation of

the spores, otherwise unknown in the genus. The nodes are similar to those of *C. macrocarpa*, but the granules with which they are filled are larger and much darker. The margin of the calyculus, with its granular rays, suggests that of *C. piriformis*.

Oregon.

12. *CRIBRARIA PIRIFORMIS* Schrad.

Nov. Gen. Pl. 4, pl. 3, figs. 4, 5. 1797.

Pl. XIV, Figs. 350, 351, 352.

1797. *Cribraria intermedia* Schrad., Nov. Gen. Pl. 4, pl. 1, fig. 2.

Sporangia gregarious, small, 0.3–0.5 mm., turbinate or pyriform occasionally globose, erect, purplish brown, stipitate; stipe comparatively short, 0.5–0.7 mm., tapering upward, longitudinally furrowed, purple or brown; calyculus very well-defined, one-third the sporangium, not ribbed but marked with minute granular lines, flattened or even umbilicate below, the margin denticulate, dusky brown; net simple, the meshes large, triangular, with few free ends; nodes thickened, slightly convex or flat, studded with dark granules; spore-mass dull brown; spores by transmitted light pale ochraceous or salmon-tinted, with distinct, pallid warts, 5–7  $\mu$ .

Schrader defined this beautiful form chiefly by its shape. This, though variable, is yet generally so far pyriform as to show distinct contraction toward the stipe. The well-defined calyculus is narrowed below and eroded or denticulate above. The cyanic tints due to the presence on the calyculus of radiating lines of purplish granules about one-half the size of the spores, the uniform, open net, the stipe rather stout, short, and distinctly furrowed, rising often from a small hypothallus—these are marks of this species. The net suggests *C. tenella*, but the latter species is much smaller, has a different stem, much longer and unfurrowed. The cup here is more nearly that of some form of *C. intricata*, but is better defined, passing into the net very abruptly by the simple intervention of projecting teeth.

Var. *notabilis* Rex ex List., Mycetozaa, 2nd edition, 182 : 1911, is a form with globose sporangia, convex nodes and more slender threads.

Var. *fusco-purpurea* Meylan, Ann. Cons. Bot. Genève 16 : 319, 1913, is described as darker and with most or all of the nodes unexpanded.

Not common. New York, Virginia, North Carolina, Tennessee, Iowa, South Dakota, Colorado, Wyoming, Washington, Oregon; Europe, Japan.

13. CRIBRARIA MACROCARPA *Schrad.*

Nov. Gen. Pl. 8, pl. 2, figs. 3, 4. 1797.

Pl. XIV, Figs. 353, 354.

1808. *Trichia macrocarpa* (Schrad.) Poiret, in Lam. Encycl. 8 : 55.1885. *Cribraria latrica* Racib., Hedwigia 24 : 170.1889. *Heterodictyon bieniaszii* Racib., Hedwigia 28 : 121.1892. *Cribraria bieniaszii* (Racib.) Massee, Mon. 60.

Sporangia more or less closely gregarious, yellowish brown, pear-shaped or obovate, large, 0.8–1 mm. in diameter, stipitate; stipe brown, furrowed, erect or often nodding, about equal to the sporangium or longer, arising from a thin iridescent hypothallus; calyculus distinct, marked by numerous dark brown radiating ribs, iridescent, perforate above, deeply dentate, and merging gradually into the elegant network, of which the dark nodes are more distinctly expanded about half way up, less so at the apex and below, the filaments exceedingly delicate, simple, with occasional free ends projecting into the small meshes; spore-mass yellowish; spores by transmitted light almost colorless, minutely roughened, 5–6  $\mu$ .

Perhaps the most striking characteristic of the present species, aside from its large size, is the peculiarly perforated cup or calyculus. Schrader's artist failed him here completely. The structure is exceedingly delicate, the peridium between the ribs and reticulations reduced to the last degree of tenuity, with the iridescence of the soap-bubble, here and there lapsed entirely. Withal the structure seems firm enough and persists until all the spores are dissipated by the wind.

Easily distinguished from *C. argillacea*, its only rival in size among the species with ochraceous spores, by the obovate or turbinate, netted sporangium, the much longer stem, and the flat, perfectly formed nodes.

Rare. New York, North Carolina, South Carolina, Ontario, Washington, Oregon, Chile; Europe.

14. CRIBRARIA TENELLA *Schrad.*

Nov. Gen. Pl. 6, pl. 3, figs. 2, 3. 1797.

Pl. XIV, Figs. 355, 356.

Sporangia gregarious, globose, small, 0.3–0.5 mm. in diameter or smaller, olivaceous or ochraceous, long-stipitate, nodding; stipe slender, dark brown or blackish, very long, reaching 6 mm., weak and flexuous; calyculus variable, sometimes well defined, brown, costate, sometimes represented by the costæ only, connected by a thin, transparent membrane; net well differentiated, the meshes small, irregular, the nodes



small, black, more or less globular, prominent, connected by transparent threads; free ends usually few, occasionally fairly numerous; spores in mass olivaceous-ochraceous, under the lens pallid, globose, almost smooth, 5–7  $\mu$ .

Very common eastward and south, on the weathered surface of rotten wood. Generally easily recognized by its very long stipe, small globose sporangium dotted with numerous small roundish nodules projecting plainly above the general surface. The obconic calyculus is always represented in the outline if not in definite structure.

New England and Ontario to Washington, south to Tennessee and Missouri, Argentina; Europe, South Africa, Ceylon, Japan.

15. *CRIBRARIA AURANTIACA* Schrad.

Nov. Gen. Pl. 5, pl. 1, figs. 3, 4. 1797.

Pl. XIV, Figs. 357, 358.

1797. *Cribraria vulgaris* Schrad., Nov. Gen. Pl. 6, pl. 1, fig. 5.

1801. *Cribraria vulgaris* Schrad. var. *aurantiaca* (Schrad.) Pers., Syn. Meth. Fung. 194.

1808. *Trichia rufescens* (Pers.) Poiret var. *aurantiaca* (Schrad.) Poiret, in Lam. Encycl. 8 : 31.

Sporangia gregarious, spherical, 0.5–0.9 mm. in diameter, dusky or yellowish, stipitate, nodding; calyculus variable, generally prominent, marked by delicate radiating veins, the margin denticulate, the teeth numerous and slender, supporting the well-defined globose net; network made up of very tenuous threads, forming rather small irregular brownish nodules and showing only here and there a free extremity; stipe generally short, two or three times the diameter of the sporangium, sometimes longer, tapering upward, brown, slender, arcuate above; spore-mass yellow or ochraceous; spores by transmitted light colorless, 5–6  $\mu$ , almost smooth.

This widely distributed and very variable species is generally recognized by the large sporangia, comparatively short stipe, simple net, and more or less orange color. The color is an uncertain thing even in the sporangia which rise from one plasmodium. Schrader, however, made this feature so far diagnostic that he placed only the more pronouncedly yellow forms in the species *C. aurantiaca* and set off as *C. vulgaris* forms in which more dusky tints prevail. The dark colored forms have also usually longer stipes, but so much is dependent upon the climatic conditions prevalent at the time of fruiting, that this feature also is indeterminate. Rostafinski's figs. 21 and 26 of pl. 2, show the characteristic nodules and the typical net structure. It is

to be observed that fig. 21 represents higher magnification; otherwise the two figures are very much alike.

New England and Ontario to Maryland, Washington and California; Europe.

16. *CRIBRARIA LAXA* *Hagelstein*

Mycologia 21 : 298. 1929.

Sporangia closely gregarious, erect, globose, 0.5–0.7 mm. in diameter, dark brown; stipe dark brown, furrowed, short, 0.7–1.4 mm. in height, calyculus occupying about one-third of the sporangium, strongly ribbed, with numerous cross veins connecting the ribs, between them a thin glistening membrane; net arising from the ribs, wide-meshed, the nodes large, thickened, dark brown, crowded with granules, free ends few, connecting threads slender and lax; hypothallus very broad; spores ochraceous in mass, pale by transmitted light, warted, 6–7  $\mu$ .

Known only from Long Island, where it was found in successive years growing on leaves, a most unusual habitat for a *cribraria*.

17. *CRIBRARIA EXIGUA* *Meylan*

Bull. Soc. Vaud. Sc. Nat. 57 : 304. 1931.

Sporangia solitary or widely scattered, minute, spherical, 0.15–0.2 mm. broad, reddish tawny, as in *C. rufa*; stipe slender, red, five or six times the diameter of the sporangium; calyculus almost lacking; net lax, with large meshes and rounded or polygonal nodes 15–20  $\mu$  in diameter, very opaque; free ends none or few; spores reddish ochraceous in mass, finely papillate, lacking dictydine granules, 7–9  $\mu$ .

Said to be related to *C. vulgaris* (*C. aurantiaca* as here interpreted). Suggesting *C. tenella* in aspect, but smaller, with coarser net and much larger spores.

Switzerland.

18. *CRIBRARIA RUFA* (*Roth*) *Rost.*

Mon. 232. 1875.

Pl. XIV, Fig. 367.

1788. *Stemonitis rufa* Roth, Fl. Germ. 1 : 548.

1794. *Cribraria rufescens* Pers., Roemer N. Mag. Bot. 1 : 91.

1797. *Cribraria fulva* Schrad., Nov. Gen. Pl. 5, pl. 1, fig. 1.

1808. *Trichia rufescens* (Pers.) Poiret, in Lam. Encycl. 8 : 55.

Sporangia scattered, subglobose or turbinate, dark or reddish orange, 0.5–0.7 mm. in diameter, erect, stipitate; stipe about equalling the

height of the sporangium or longer, dark brown or black; calyculus one-third to one-half the sporangium, the margin toothed, the wall ribbed and continuous with the open wide-meshed net; network deep yellow or orange, the threads flattened; nodes expanded but not thickened, with large light granules; free ends none; spores concolorous, pale yellow by transmitted light, verruculose, 5-7  $\mu$ .

Similar to *C. minutissima* but much larger and deep yellow to orange in color. *C. intermedia* Schrad., cited in the Lister monograph as a synonym, because of its pyriform shape, equal network and the small number of veins in the lower part, should rather be included in *C. piriformis*.

Montana, Washington, Oregon, Prince Edward Island; Europe, Japan.

#### 19. CRIBRARIA RUBIGINOSA *Fr.*

Syst. Myc. 3 : 172. 1829.

Sporangia gregarious, usually in large colonies, erect, stipitate, elliptical, dull crimson or metallic bronze, 1-1.5 mm. in diameter; calyculus occupying about one-half of the sporangium, the exterior studded with small, ruby red plasmodic granules; the margin serrate; net arising irregularly from the margin of the calyculus, with large meshes; nodes somewhat expanded, dull red, not thickened nor granular; free ends few, arising from the broad threads; hypothallus brownish red, well developed, common to a group of sporangia; stipe very variable in length, dark red to purple-brown, rather stout; spore-mass reddish brown; spores by transmitted light dull ruby red, with bright red granules within, minutely warted, 5-6  $\mu$ . Plasmodium purple-black.

Distinguished by the large, dull red sporangia, the irregularly branching net, and the spores with granules within. Unusually long-stalked forms have been named var. *longipes* Meylan (Bull. Soc. Vaud. 44 : 294, 1908). Brandza (1929, p. 274) points out that these are more iridescent, that the granules are differently disposed on the peridium and that the spores are slightly smaller. He believes it should be regarded as a distinct species for which he suggests the name *C. meylani*.

On coniferous wood. Europe.

#### 20. CRIBRARIA FERRUGINEA *Meylan*

Ann. Cons. Bot. Genève 16 : 319. 1913.

Sporangia gregarious, subglobose, 1-1.5 mm. in diameter, on a membranous hypothallus; calyculus poorly defined, marked by broad,

dark ribs, held together by a thin metallic membrane; net branching irregularly from the ribs, the nodes barely expanded, reddish brown, granular, the threads slender; stipe dark brown, furrowed, short, 0.5–1 mm. in length; spores brick-red or orange-red in mass, pale by transmitted light, warted, 5–7  $\mu$ .

The ribbed calyculus suggests that of *C. macrocarpa* but the nodes are not thickened as in that species, and the spores are brick-red in color.

On coniferous wood. Oregon, New Mexico; Switzerland, Poland.

## 21. CRIBRARIA PURPUREA *Schrad.*

Nov. Gen. Pl. 8. 1797.

Pl. XIV, Figs. 359, 360.

Sporangia gregarious, depressed-globose, large, 1 mm. or more in diameter, reddish purple, erect, stipitate; stipe concolorous, furrowed, about twice the diameter of the sporangium in length, with a distinct hypothallus; calyculus persistent, less than half the sporangium, obscurely ribbed, marked by concentric plications, the margin toothed; net poorly differentiated, the meshes irregular in form and size, as are also the flat, unthickened nodes, the threads pale, broad, free ends short and not numerous; spore-mass purple; spores by transmitted light pale or colorless, 5–7  $\mu$ , nearly smooth.

Rare. Found on rotten coniferous wood in deep forests. Easily recognized by its large size and uniform purple color. The purple color is soluble in water and often colors the substratum. The species bears a general resemblance to *C. elegans*, but has larger sporangia and an entirely different net. Professor Brandza finds forms which he regards as somewhat intermediate. The plasmodium just before the formation of the fruit is scarlet.

Maine, New York, Pennsylvania, Ontario, Colorado, Montana, Washington, Oregon; Europe, Japan.

## 22. CRIBRARIA LEPIDA *Meylan*

Bull. Soc. Vaud. Sc. Nat. 56 : 326. 1927.

Sporangia scattered, spherical, 0.25–0.5 mm. in diameter, long-stipitate, erect, very dark blue; calyculus occupying one-third to one-half the sporangium, marked by fine granular ribs, the margin nearly straight, not perforated, the plasmodic granules very dark blue, nearly black; net prominent, the meshes large, the nodes large, round, thickened, crowded with black granules, connecting threads rounded with a few dark granules, free ends none; hypothallus none;



stipe black, slender, 2-6 mm. in length; spore-mass black; spores by transmitted light pale blue, minutely spinulose, 6-8  $\mu$ . Plasmodium white.

Resembling *C. languescens* in form and size, but with a proportionately longer stipe. The dark blue color, almost black, and the large, dark granules in the calyculus and nodes are distinctive.

On very rotten wood. Switzerland.

### 23. CRIBRARIA ELEGANS Berk. & Curt.

Grev. 2 : 67. 1873.

Pl. XIV, Figs. 361, 362.

Sporangia gregarious, globose, erect or nodding, small, 0.4-0.5 mm., deep lilac or reddish purple, stipitate; stipe long, slender, tapering upward, almost black, arising from a scanty hypothallus; calyculus about half the sporangium, finely ribbed, covered especially above with small purple granules, the margin toothed or perforate; net well developed, the meshes small, polygonal, the threads delicate, colorless with many free ends; nodules dark colored, numerous and somewhat prominent; spore-mass purple; spores by transmitted light pale violaceous, smooth, 6-6.5  $\mu$ .

To be compared with *C. purpurea*. The small-meshed net with well-defined dark colored nodules is distinctive, aside from the fact of the much smaller sporangia. The stipe is also different, more slender, smooth and dark colored. The habitat of the two species appears to be the same. The present species is the more common.

Nova Scotia, New York, Pennsylvania, South Carolina, Missouri, Iowa, South Dakota, Washington.

### 24. CRIBRARIA VIOLACEA Rex

Proc. Acad. Nat. Sc. Phila. 1891 : 393.

Pl. XIV, Figs. 363, 364.

Sporangia scattered or gregarious, very small, 0.2-0.3 mm. in diameter, violet, erect, stipitate; stipe short, about one-half the total height, concolorous, slender, tapering upward; calyculus crateriform, occupying about two-thirds of the sporangium, persistent, marked with minute plasmodic granules; net rudimentary or poorly developed, the meshes large, irregular, the nodules also large-triangular, violaceous; spores pale violet in mass, lilac by transmitted light, 7-8  $\mu$ , minutely warted. Plasmodium violet-black.

A very minute but well-marked species discovered by Dr. Rex in Wissahickon Park, near Philadelphia; rarely collected. In minuteness

to be compared with *C. minutissima*, from which its color instantly distinguishes it. Usually on very rotten basswood, *Tilia americana*, but reported on a variety of substrata. Characterized by the minute, bell-shaped, violet sporangia with a few large, flat nodes.

Pennsylvania, Florida, Illinois, Iowa, West Indies; Europe, Kamerun, Ceylon, Malay Peninsula, Japan.

### 3. *Dictydium* Schrad. emend. Rost.

Vers. 5. 1873.

1797. *Dictydium* Schrad., Nov. Gen. Pl. 11, in part.

Sporangia distinct, gregarious, globose or depressed-globose, stipitate, cernuous; peridium very delicate, evanescent, thickened on the inside by numerous meridional costæ which are joined at frequent intervals by fine transverse threads more or less parallel to each other, forming a persistent network of rectangular meshes.

Schrader applied the name *Dictydium* to all *Cribraria*-like species in which the calyculus was wanting, and in this was followed by Fries (Syst. Myc. 3 : 164). Rostafinski first defined the genus in its modern sense.

We here recognize a single species, extremely common, and widely distributed throughout the world. It is remarkably variable, and many of its more constant variants have been deemed worthy of varietal and even specific distinction.

#### DICTYDIUM CANCELLATUM (*Batsch*) *Macbr.*

N. A. Slime-Moulds 172. 1899.

Pl. XV, Figs. 371, 372.

1789. *Mucor cancellatus* Batsch, Elench. Fung. Cont. 2 : 135.

1791. *Stemonitis cancellata* (Batsch) Gmel., Syst. Nat. 2 : 1468.

1796. *Cribraria cernua* Pers., Obs. Myc. 1 : 91.

1797. *Dictydium umbilicatum* Schrad., Nov. Gen. Pl. 11, pl. 4, fig. 1.

1808. *Trichia cernua* (Pers.) Poir., in Lam. Encycl. 8 : 54.

1816. *Dictydium cernuum* (Pers.) Nees, Syst. Pilze 120.

1826. *Cribraria trichioides* Chev., Fl. Par. 327.

1893. *Dictydium longipes* Morg., Jour. Cin. Soc. Nat. Hist. 15 : 143.

Sporangia gregarious, depressed-globose, nodding, the apex at length umbilicate, stipitate, brown or brownish purple; stipe varying in length from two to ten times the diameter of the sporangium, attaining 5-6 mm., generally erect, more or less twisted and pallid at the apex, below dark brown, with hypothallus small or none; calyculus often wanting, when present a mere film connecting the ribs of the

net; net made up chiefly of meridional ribs connected at intervals by transverse parallel threads, an open Cribraria-like network above closing the apex and more or less rudimentary; spores varying in color through all shades of brown and purple when seen in mass, by transmitted light reddish, 5-7  $\mu$ , smooth or nearly so.

Extremely variable, but the varieties grading into each other so as to make attempted definition of slight value. There seems to be no correlation, as some have supposed, between color and length of stipe, but the more purple forms may be in part cases of arrested development, since the plasmodium appears to be always purplish. In the typical form the sporangia are brown with only slight suggestion of purple, the stipe from three to ten times the diameter of the sporangium, tapering upward and paler to white at the twisted apex; the reticulations of the net numerous, the meshes small. The following varieties have been recognized:

Var. *purpureum* Macbr., N. A. Slime-Moulds 173 (= *Cribraria exilis* Macbr., Nat. Hist. Bull. Iowa 2 : 378, 1893). Cup often present, reticulations coarser, color purplish throughout.

Var. *prolatum* Macbr., N. A. Slime-Moulds ed. 2. 232, 1922. Rosy brown, sporangium more erect, ellipsoidal, not at all compressed.

Var. *fuscum* Lister, Jour. Bot. 36 : 120, 1898. Dark brown, with a well-defined cup.

Var. *alpinum* Lister, Mycetozoa ed. 2. 185, 1911 (= *Dictydium anomalum* Meylan, Bull. Soc. Vaud. 44 : 295, 1908; *Dictydium mirabile* (Rost.) Meylan, Bull. Soc. Vaud. 57 : 305, 1931; *Heterodictyon mirabile* Rost., Mon. 231, 1875; *Cribraria mirabilis* (Rost.) Mass., Mon. 60, 1892). Sporangia globose, erect, ribs 20-30, branching in upper third of sporangium to form an irregular net; stalk not narrowed at apex, often rugged.

Var. *anomalum* Jahn, Ber. Deutsch. Bot. Ges. 19 : 99, 1901 (= *Dictydium ambiguum* Schrad., Nov. Gen. Pl. 13, 1797). Ribs branching and anastomosing to form a Cribraria-like net.

Several of these variations are pictured on pl. XIX of N. A. Slime-Moulds, 2nd edition.

Common throughout the world, the fructifications often extending for several feet.

#### FAMILY LICEACEÆ

Sporangia scattered, plasmodiocarpous, sessile or stalked, sporangium wall cartilaginous or rarely membranous; capillitium lacking or represented by a few thread-like processes.

## KEY TO THE GENERA OF THE LICEACEÆ

- a. Dehiscence by regular lobes, or irregular; sporangia mostly sessile, subglobose or plasmodiocarpous. . . . . 1. *Licea*
- a. Dehiscence by a membranous lid. . . . . b
- b. Sessile; lid minutely and densely papillate. . . . . 2. *Hymenobolina*
- b. Sessile; lid bearing scattered, globular warts, 1–2  $\mu$  in diameter, and short, blunt, tubular processes. . . . . 3. *Kleistobolus*
- b. Stalked, rarely sessile; opening by a minutely papillate lid, or by one or more ridges. . . . . 4. *Orcadella*

1. *Licea* Schrad. emend. Rost.

Mon. 218. 1875.

1797. *Licea* Schrad., Nov. Gen. Plant. 16, in part.

Sporangia plasmodiocarpous, looped, irregular or distinct, sessile and regularly rounded or elliptical; peridium simple, rather firm, ruptured irregularly or by simple fissure; hypothallus none.

This genus is distinguished from other similar plasmodiocarpous forms by the extreme simplicity of its structure. In some species there is absolutely no capillitium nor anything like it, simply a mass of spores surrounded by thin membranous walls; in others there is a scanty development of unsculptured threads which are never very apparent. The spores range from pale olive, colorless under the lens, through various shades of brown to dusky, almost black, in *L. pusilla*. Schrader included in the genus the forms now included in *Tubifera*.

## KEY TO THE SPECIES OF LICEA

- a. Short to long, flattened plasmodiocarps, often branched. . . . . 1. *L. variabilis*
- a. Separate sporangia or short, pulvinate plasmodiocarps. . . . . b
- b. Yellow or brownish, not dark. . . . . c
- b. Deep purplish to black. . . . . e
- c. Elongate, with membranous peridium; dehiscence by a longitudinal fissure. . . . . 6. *L. biforis*
- c. Pulvinate or subglobose; peridium more or less cartilaginous; dehiscence not by a longitudinal fissure. . . . . d
- d. Subglobose on a narrowed base; dehiscence irregular; bright yellow-brown. . . . . 2. *L. tenera*
- d. Pulvinate or forming short plasmodiocarps; dehiscence by regular plates or lobes; chestnut or pale brown. . . . . 3. *L. castanea*
- e. Spores 4–5  $\mu$ , spherical, each with a distinct umbilicus. . . . . 7. *L. hungarica*
- e. Spores larger, without umbilicus. . . . . f
- f. Umber to black, dull; spores 10–12  $\mu$ . . . . . 4. *L. minima*
- f. Dark purplish brown, shining; spores larger. . . . . g
- g. Spores 13–17  $\mu$ , dark, smooth, on wood. . . . . 5. *L. pusilla*
- g. Spores 12–20  $\mu$ , with long, detachable, spine-like processes partly covering the spore wall; on dung. . . . . 8. *L. fimicola*



1. *LICEA VARIABILIS* Schrad.

Nov. Gen. Pl. 18, pl. VI, 5, 6, 1797.

Pl. XV, Figs. 373, 374.

1801. *Licea flexuosa* Pers., Syn. Meth. Fung. 197.1808. *Tubulina flexuosa* (Pers.) Poiret, in Lam. Encycl. 8 : 131.1833. *Licea alutacea* Wallr., Fl. Crypt. Germ. 2 : 344.

Fructification plasmodiocarpous, elongate, hamate, annulate or irregularly repent, very dark brown, rough; peridium of two layers, closely adhering, the outer dark brown, thick, opaque, the inner delicate, membranous, very thin, transparent, iridescent, rugulose, rupturing irregularly; hypothallus none; spores in mass pale yellow with a greenish tinge, by transmitted light nearly colorless, large, globose or broadly oval and often somewhat angular, with a thick wall, thicker at the angles, minutely spinulose, 12–15  $\mu$ .

This is the largest species of the genus, the plasmodiocarps reaching 1–6 mm. in length and from 0.5–0.7 mm. wide. Somewhat resembling some species of *Ophiotheca*, but of much darker color. The outer peridium is deciduous, and the inner slowly ruptures, by irregular fissures discharging the spores. The plasmodium, according to Schrader, is white; Lister says dull yellow or rose colored. Rare. Probably overlooked.

Any good reason for changing the name given to this form so well illustrated and described by Schrader does not appear. Persoon quotes his predecessor's species and adds *L. flexuosa* on his own account; strangely enough, since Schrader expressly describes *L. variabilis*, "In uno eodemque enim loco peridium hemisphaericum, ovatum, oblongum, flexuosum vel aliter formatum diversi est diametri."

*Licea flexuosa* Pers. is reported by Schweinitz from Pennsylvania. It is described as having brown spores, 10–15  $\mu$ , spinulose.

Nova Scotia, Ontario, New York, Pennsylvania, Ohio, Iowa, South Dakota, Washington; Europe.

2. *LICEA TENERA* Jahn

Ber. Deutsch. Bot. Ges. 36 : 665, pl. 18, figs. 4–6, 1919.

Sporangia sessile on a constricted base, subglobose or ovoid, 0.3–0.4 mm. in diameter, bright yellow-brown; sporangium wall transparent, yellow-brown, almost free from refuse matter; dehiscence irregular; spores pale olive-yellow, minutely spinulose, with a thin area on one side, 10–12  $\mu$ .

Very close to *L. variabilis* but differing in the sporangiate rather

than plasmodiocarpous fructification and in the thinner walls with little refuse matter.

Iowa, Oregon; Bavaria, England, Rumania.

3. *LICEA CASTANEA* G. *List.*

Jour. Bot. 49 : 61. 1911.

Sporangia scattered, sessile, subglobose or forming short plasmodiocarps, 0.2–0.9 mm. long, 0.2–0.4 mm. wide, chestnut or pale brown; sporangium wall dehiscing along definite lines to form plates or lobes; spores olive-yellow in mass, almost colorless under the microscope, smooth, 8–10  $\mu$ .

Differing from *L. minima* in the paler sporangia and smaller, smooth, pale spores.

Scotland, Switzerland.

4. *LICEA MINIMA* Fr.

Syst. Myc. 3 : 199. 1829.

Pl. XV, Figs. 377, 378.

1892. *Tubulina minima* (Fr.) Mass., Mon. 36.

Sporangia gregarious, sessile, umber-brown, spherical or hemispherical, mostly 0.2–0.4 mm. in diameter; peridium opaque, brown, opening along prefigured lines, forming segments with dotted margins, ultimately widely reflexed; spores in mass dark brown, by transmitted light paler with olive tints, globose to slightly oval, minutely roughened or nearly smooth, mostly 10–11  $\mu$ . Plasmodium yellow.

The very minute sporangia of this species cause it to be overlooked generally by collectors. Nevertheless, it is not infrequent, usually on bark or decaying wood. An abundant collection from Colorado is on an old polypore. The larger specimens might be mistaken for species of *Perichæna*, but are easily distinguished by the regular and lobate dehiscence.

Doctor George Rex, in almost the last paper from his hand, gives an interesting account of this diminutive species. Among various gatherings studied he found a black variety, and was able to follow the evolution of the sporangia from the yellow plasmodium. The sutures by which the peridium opens first show signs of differentiation by change of color from yellow through garnet to black. Later the entire wall undergoes similar color changes, beginning next the completed sutural delimitations. The reflexed segments of the open sporangia remind one of certain didermas, as *D. radiatum*. See Bot. Gaz. 19 : 399.

New England, New York, Pennsylvania, Iowa, Colorado; Europe, Japan.

5. *LICEA PUSILLA* Schrad.

Nov. Gen. Plant. 19. pl. VI, 4. 1797.

1808. *Trichia pusilla* (Schrad.) Poiret, Lam. Encycl. 8 : 131.1829. *Physarum licea* Fr., Syst. Myc. 3 : 143.1875. *Protoderma pusilla* (Schrad.) Rost., Mon. 90.1888. *Protodermium pusillum* (Schrad.) Berl., in Sacc. Syll. Fung. 7 : 328.

Sporangia scattered, gregarious, depressed-globose, sessile on a flattened base, dark purplish brown, shining, 0.5–1 mm.; peridium thin, dark colored, translucent, dehiscent above by regular segments; spore-mass dark olive, almost black; spores by transmitted light olivaceous brown, smooth or nearly so, 13–17  $\mu$ . Plasmodium chrome-yellow.

Fries thought this a *physarum*, and argued the case at length, evidently with such efficiency that he greatly impressed Rostafinski, who did not make it a *physarum* indeed, but actually gave it generic place and station of its own; a *physarum* may do without calcium in the capillitium perhaps, but not be entirely non-calcareous; so he writes *Protoderma* (first cover) and places the species number 1 on the long list of endosporous forms. In his supplement, he refers to the thing again, but only to correct the inflexional ending of the specific name; he writes *Protoderma pusillum* (Schrader) Rost.!

Schweinitz reports the species for America. Morgan merely cites Schweinitz. We have one collection from Iowa.

North Carolina, Iowa; Europe.

6. *LICEA BIFORIS* Morgan

Jour. Cin. Soc. Nat. Hist. 15 : 131. 1893.

Pl. XV, Figs. 375, 376.

Sporangia regular, compressed, sessile on a narrow base, gregarious, up to 0.2 mm. long and 0.05–0.1 mm. broad; walls firm, thin, smooth, yellow-brown in color and nearly opaque, with minute, scattered granules on the inner surface, at maturity opening into two equal parts, which remain persistent by the base; spores yellow-brown in mass, globose or oval, minutely roughened, 9–12  $\mu$ .

Minute but perfectly regular, almost uniform, corneous-looking sporangia are thickly strewn often over the inner surface of decaying bark. Each, at first elongate, pointed at each end, opens at length by fissure along the upper side setting free the minute yellowish spores. Unlike anything else; reminding one, at first sight, of some species of *Glonium*. Miss Baker notes that a cross section shows the spores arranged in regular radial series.

Ontario, Pennsylvania, Ohio, Iowa; Manchuria, Japan.

7. *LICEA HUNGARICA* Moesz

Folia Cryptogamica 1 : 159. 1925.

Pl. XV, Fig. 379.

Sporangia gregarious, sessile, globose or hemispherical, 0.15–0.3 mm. in diameter; peridium thick, opaque, fragile, black, smooth, shining; dehiscence irregular or more or less radiate, somewhat roughened under the lens; capillitium very scanty, the filaments sparsely branched, more or less anastomosing, hyaline or pale fuscous, in part extremely slender, partly fasciculate; spores depressed-globose, ferruginous in mass, pale fuscous by transmitted light, smooth, 4–5  $\mu$ . Plasmodium unknown.

An extremely curious form, unlike anything else. Through the kindness of Dr. Moesz we have been permitted to examine a portion of the type. The spores are globose or somewhat flattened, with a curious umbilicus at one side, and tend to cling together in masses. These characters are not mentioned in the Latin diagnosis of the author (l. c. 193) but are well shown in the drawing accompanying the description in Hungarian.

Hungary. On frondose wood.

8. *LICEA FIMICOLA* Dearness & Bisby

Fungi of Manitoba 52. 1929.

Pl. XV, Figs. 380, 381.

Sporangia scattered or gregarious, spindle-shaped, oval or roundish; wall membranous, shining, even, reddish purple, becoming blackish purple, 0.3–0.5 mm. high, 0.12–0.2 mm. wide, dehiscence irregular; capillitium sparse, of occasional small, smooth threads which may bear lime-knots; spores spherical, purplish, fading in liquid to slate or brown, with short echinulations on one side, or irregularly dispersed in areas, remainder of spore smooth, 11–15  $\mu$ , sometimes larger. Plasmodium pinkish white.

On horse dung cultures in laboratory. Winnipeg, Manitoba.

Specimens included in a portion of the type collection received through the kindness of Professor Dearness do not quite agree with the description given above, which is somewhat abbreviated from the original. The sporangia are often much smaller, 0.05 mm. in diameter, and a shining black, both changes being due undoubtedly to drying. There are absolutely no markings of any sort on the spores nor is there any certain evidence of capillitium, the only threads apparent being fungus hyphæ. A later collection received from Dr. Bisby has larger spores, averaging 18.4  $\mu$  in diameter, with thick walls bearing the



structures described as spines or echinulations largely on one side. These latter are easily detached, quite unlike the ordinary wall markings of a myxomycete spore, and seem to be rather of the nature of plasmodic secretions. In this later collection there are a few short, but unmistakable capillitial threads attached to the sporangium wall. These are about  $1\mu$  in diameter, with frequent plasmodic, not calcareous, thickenings. In spite of the very rudimentary capillitium, the form is best regarded as a *Licea*, and quite distinct from any other species.

## 2. *Hymenobolina* Zukal

Æsterr. Bot. Zeitschr. 43 : 133. 1893.

1893. *Hymenobolus* Zukal, Æsterr. Bot. Zeitschr. 43 : 73. 1893, *non* Dur. & Mont.

Sporangia solitary, sessile, brownish gray, opening by a membranous lid; wall single, limeless; capillitium none; spores smooth. Parasitic on lichens, mosses and algæ.

Distinguished from *Licea* by the possession of a lid and the curious parasitic habit of growth. According to the author it shows other differences in its development which substantiate the claim to generic separation. The plasmodium does not move about but forms a nearly stationary mass which gradually penetrates the substratum. In dry weather it contracts to form characteristic reddish cysts.

A single species:

### HYMENOBOLINA PARASITICA Zukal

Æsterr. Bot. Zeitschr. 43 : 133. 1893.

Pl. XVI, Figs. 397, 398.

1893. *Hymenobolus parasiticus* Zukal, Æsterr. Bot. Zeitschr. 43 : 73.  
1919. *Licea singularis* Jahn, Ber. Deutsch. Bot. Ges. 36 : 665.

Sporangia scattered, sessile, subglobose or forming short plasmodiocarps, 0.05–0.2 mm. in diameter, brownish gray, opaque or glossy, dehiscing irregularly or by a well-defined lid, which may be either smooth or areolate; sporangium wall membranous, pale purplish, minutely papillose on the inner surface of the lid or throughout, the lower part charged with refuse matter; spores subglobose, smoky brown on one side, fading to pallid on the other, and surrounded by a pale gelatinous sheath about  $1\mu$  thick; diameter, without the sheath, 11–16  $\mu$ . Plasmodium red.

This curious species occurs rather commonly on the bark of various

trees kept in a moist chamber for a week or ten days, sometimes growing on the bark directly.

On lichens, algæ and moss on the bark of trees. Iowa, West Virginia; Europe.

### 3. *Kleistobolus Lippert*

Verh. Zool.-Bot. Ges. Wien 44 : 70. 1894.

Sporangia sessile, minute, opening by a distinct lid, the latter bearing globular warts near the margin and short, blunt, finger-like processes at the center; spores pale lilac-brown.

A single species:

#### KLEISTOBOLUS PUSILLUS *Lippert*

Verh. Zool.-Bot. Ges. Wien 44 : 70. 1894.

Pl. XXI, Figs. 555, 556, 557, 558.

Sporangia scattered, sessile, operculate, very small, 0.04 to 0.15 mm. in diameter, discoid, rarely subglobose, circular or ellipsoid in outline; peridium simple, membranous, brown, more or less opaque from dark deposits except at the upper margin, which is bordered by a row of tubercles, 1–2  $\mu$  in diameter; operculum thin, membranous, pellucid, iridescent, with a convex center bearing on its lower surface blunt, finger-like processes, and a circular margin bearing larger warts or tubercles; spores lilac-brown or pinkish in mass, nearly colorless under the lens, smooth, but more or less coated with granular material, mostly 9–11  $\mu$ , but varying considerably in size. Plasmodium watery blackish brown.

This microscopic species was for many years known only from the original Austrian collection, which developed on coniferous wood kept in a moist chamber. More recently it has been found by Jarocki in the mountains of Poland and by him carefully described (1927). His account is in the main confirmed by G. Lister (Jour. Bot. 65 : 202, 1927). We have found it in Iowa and are able to account for certain discrepancies between the two accounts. The spores seem always to be smooth, but more or less coated with amorphous granules. They are at first large, 13  $\mu$  or more in diameter, with thin walls and scattered granules. Later they become smaller, the outer walls become thicker and the granules are aggregated as irregular deposits on the surface.

The sporangia resemble those of *Hymenobolina* but are smaller and brighter in color, and the warts on the lid are clearly visible under a good lens. The spores, when mature, are smaller and have a lilaceous tinge in marked contrast with the smoky spores of *Hymenobolina*.

The operculum is distinctive. It may be doubted, however, whether the distinctions between the two are of more than specific value.

Iowa; Austria, Poland. On coniferous and frondose wood.

#### 4. *Orcadella Wingate*

Proc. Acad. Nat. Sc. Phila. 1889 : 280.

Sporangia stalked, stipes rigid, unpolished, blending above with the substance of the thick unpolished walls; the operculum thin, delicate, membranaceous.

A single species:

#### ORCADELLA OPERCULATA *Wingate*

Proc. Acad. Nat. Sc. Phila. 1889 : 280.

Pl. XVI, Figs. 399, 400.

Sporangia scattered, gregarious, ellipsoidal, ovoid, obconical or nearly globose, dull brown or blackish, 0.4–1 mm. tall, the sporangium 0.1–0.3 mm. in diameter; wall simple, thick, coarse, at the top replaced by a delicate, thin, yellowish, iridescent, lustrous or vernicose membrane which forms a circular, smooth or wrinkled lid, soon deciduous; stipe of varying height, rough from deposit of plasmodic refuse; spores in mass yellowish, colorless under the lens, globose, smooth, 8–11  $\mu$ . Plasmodium deep orange.

This curious little species, well described by its discoverer, appears to be very rare. At least it is seldom collected; perhaps overlooked by reason of its minuteness. It is a stipitate licea, or a lid-covered cribraria; perhaps nearer the former. It occurs on the bark of various trees, sometimes associated with *Clastoderma debaryanum*.

Maine, Vermont, Pennsylvania, Iowa; Europe, Japan.

Var. *sessile*, G. Lister, Mycetozoa ed. 3. 186, 1925, is, as the name implies, a stalkless variety, known from England only.

#### FAMILY TUBIFERACEÆ

Sporangia cylindrical or elliptical, clustered, the clusters sessile or stalked; sporangium wall membranous, without plasmodic granules; pseudocapillitium and columella or true capillitium sometimes present.

#### KEY TO THE GENERA OF THE TUBIFERACEÆ

- Sporangia cylindrical, densely clustered, sessile or on a stalk-like  
hypothallus. . . . . 1. *Tubifera*  
Sporangia ovate, in a loose cluster on a common stalk; capillitium a  
tuft of bristle-like tubes. . . . . 2. *Alwisia*

Sporangia sessile, flattened, closely clustered into a pseudo-æthallium, rarely scattered; capillitium of slender branching threads with expanded nodes. . . . . 3. *Liceopsis*

### 1. *Tubifera* Gmelin

Syst. Nat. 2 : 1472. 1791.

1794. *Tubulina* Pers., Roemer N. Mag. Bot. 1 : 91.

Sporangia tubular, by mutual pressure more or less prismatic, connate, pale ferruginous brown, iridescent, walls thin, slightly granular, long-persistent; dehiscence apical; hypothallus thick, spongy, white or whitish; spore-mass ferruginous.

This genus is easily recognized by the tubular sporangia, destitute of capillitial threads, seated upon a strongly developed hypothallus. The synonymy of the case is somewhat difficult. It is possible that Müller's *Tubulifera ceratum* (Fl. Dan., 1775, p. 8) may belong here, but neither the text nor the figures make it certain. Neither he nor Eder, who gives us *T. cremor* in the same work, had any accurate idea of the objects described. Gmelin's description of *Tubifera* is, however, ample, and his citations of Bulliard's plates leave no doubt as to the forms he included. Gmelin writes: "Thecæ (membranæ expansæ superimpositæ) inter se connatæ, seminibus nudiusculis repletæ." Why, in face of so good a description, Persoon changed the name to *Tubulina*, is not clear. Fries (Syst. Myc. 3 : 195) thinks Müller had an immature *Arcyria* before him. *Tubulifera arachnoidea* Jacq., 1778, is also an uncertain quantity, insufficiently described.

#### KEY TO THE SPECIES OF TUBIFERA

- a. Pseudocolumellæ present in most of the sporangia. . . . . 3. *T. casparyi*
- a. Pseudocolumellæ lacking. . . . . b
- b. Hypothallus thick, expanded, not columnar. . . . . 1. *T. ferruginosa*
- b. Hypothallus stalk-like, columnar. . . . . 2. *T. stipitata*

### 1. *TUBIFERA FERRUGINOSA* (Batsch) Gmelin.

Syst. Nat. 2 : 1472. 1791.

Pl. XV, Figs. 382, 383.

- 1786. *Stemonitis ferruginosa* Batsch, Elench. Fung. Cont. 1 : 261, fig. 175.
- 1791. *Sphærocarpus cylindricus* Bull., Champ. 140, pl. 470, fig. 3.
- 1791. *Sphærocarpus fragiformis* Bull., Champ. 141, pl. 384.
- 1791. *Tubifera cylindrica* (Bull.) Gmel., Syst. Nat. 2 : 1472.
- 1791. *Tubifera fragiformis* (Bull.) Gmel., Syst. Nat. 2 : 1472.
- 1794. *Tubulina fragiformis* (Bull.) Pers., Roemer N. Mag. Bot. 1 : 91.
- 1796. *Lycoperdon favaceum* Schrank, Baier. Fl. 2 : 667.



1797. *Tubulifera coccinea* Trentep., Roth, Cat. Bot. 1 : 243.  
 1797. *Licea tubulina* Schrad., Nov. Gen. Pl. 16.  
 1797. *Licea clavata* Schrad., Nov. Gen. Pl. 18.  
 1799. *Tubulina fallax* Pers., Obs. Myc. 2 : 28.  
 1805. *Tubulina cylindrica* (Bull.) DC., Fl. Fr. 2 : 249.  
 1808. *Tubulina fragifera* Poir., Lam. Encycl. 8 : 130.  
 1816. *Licea fragiformis* (Bull.) Nees, Syst. 107.  
 1829. *Licea cylindrica* (Bull.) Fr., Syst. Myc. 3 : 195.  
 1847. *Licea iricolor* Zoll., Flora 30 : 300.  
 1851. *Tubulina conglobata* Preuss, Linnæa 24 : 40.  
 1860. *Licea rubiformis* Berk. & Curt., Proc. Am. Acad. Arts & Sc. 4 : 125.  
 1881. *Tubulina nitidissima* Berk., Jour. Linn. Soc. 18 : 387.  
 1881. *Tubulina speciosa* Speg., Atti Soc. Critt. Ital., 2 ser. 3 : 62.

Sporangia crowded, cylindric or prismatic, elongate, connate, more or less distinct above, pale umber-brown, generally simple though occasionally branched above, the peridia thin, sometimes fragile, but generally persistent, transparent, iridescent; hypothallus strongly developed, spongiöse, white, often projecting beyond the æthalioid mass of sporangia; spore-mass umber-brown or ferruginous; spores by transmitted light almost colorless, plainly reticulate over three-fourths of the surface, 6-8  $\mu$ . Plasmodium colorless, rarely yellow.

Easily known by its long, tubular sporangia packed with rusty spores and destitute of any trace of columella or capillitium, the hypothallus explanate, rather thick, but not columnar. A single plasmodium may give rise to one or several colonies, at first watery or white, then red, of somewhat varying shades, then finally umber-brown. These colors were noticed by all the older authors, but very inaccurately; thus a white plasmodium is the basis for *Tubifera cylindrica* (Bull.) Gmel., a roseate plasmodium for *Tubifera fragiformis* (Bull.) Gmel., and the mature fructification for *Tubifera ferruginosa* (Batsch) Gmel. Rostafinski adopted a specific name given by Bulliard, but Batsch has clear priority.

The peridia are sometimes acuminate, and widely separate above. This is Persoon's *Tubulina fragiformis*. In most cases, however, the peridia are connate throughout, and sometimes present above a membranous common covering. This is *Tubulina fallax* of Persoon; *Licea cylindrica* (Bull.) Fries. In forms with thicker peridia, the walls often show granular markings.

Var. *complanata* Meylan (Bull. Soc. Vaud. 57 : 305, 1931), described from Switzerland, is distinguished by its dark purple-brown color and the great size of its fructifications, which may exceed 50 cm. in length.

Throughout the northern hemisphere, Brazil; South and West Africa.

2. TUBIFERA STIPITATA (*Berk. & Rav.*) *Macbr.*

N. A. Slime-Moulds 157. 1899.

Pl. XV, Figs. 384, 385.

1860. *Licea stipitata* Berk. & Rav. ex Berk. & Curt., Proc. Am. Acad. Arts & Sc. 4 : 125, non DC. 1815.1873. *Licea microsperma* Berk. & Curt., Grev. 2 : 68.1875. *Tubulina stipitata* (Berk. & Rav.) Rost., Mon. 223.

Sporangia crowded in a globose or more or less hemispheric, expanded head, borne upon a spongy, stem-like, sulcate hypothallus 3-4 mm. high, their apices rounded, their walls very thin, evanescent; spores in mass umber-brown, small, about  $5\mu$ , the epispore reticulate as in the preceding species.

This differs from the preceding species chiefly in the cushion-like receptacle on which the crowded sporangia are borne, and in the smaller spores. The fructification originates in a plasmodium at first colorless, then white, followed by salmon or buff tints, which pass gradually into the dark brown of maturity. This peculiar succession of colors is perhaps more diagnostic than the difference in habit. The spores are, however, constantly smaller in all the specimens we have examined, and the stipitate habit very marked.

New England, New York, south to South Carolina and the West Indies, west to Wisconsin, South Dakota and Missouri, Dutch Guiana, Brazil, Argentina; Ceylon, Malay Peninsula, Japan.

3. TUBIFERA CASPARYI (*Rost.*) *Macbr.*

N. A. Slime-Moulds 157. 1899.

1876. *Siphoptychium casparyi* Rost., Mon. App. 32.

Sporangia closely crowded, tubular, cylindric or prismatic by mutual pressure, connate, the apices rounded, convex, covered by a continuous membrane, umber-brown; the peridia firm, persistent, minutely granular, iridescent; hypothallus well developed, thin, brown, explanate; pseudocolumellæ erect, rigid, traversing many of the sporangia, and in some instances bound back to the peridial walls by slender, membranous bands or threads, a pseudocapillitium; spore-mass dark brown or umber; spores by transmitted light pale, globose, reticulate,  $7.5-9\mu$ .

Rostafinski proposed the genus *Siphoptychium* to accommodate this species. Rex (Bot. Gaz. 15 : 319) showed that the relationships of the species are with *Tubifera*; that the so-called columella is probably an abortive sporangium; the so-called capillitial threads having no homology with the capillitial threads of the true columelliferous

forms. It is a good species of *Tubifera*, nothing more. The tubules are shorter than in either of the preceding species; the spores are darker, larger, and more thoroughly reticulate. The plasmodium is given by Rex as white, then "dull gray tinged with sienna color," then various tones of sienna-brown, to the dark umber of the mature aethalium.

Usually of moderate size, the fructification sometimes becomes very large. In the Ellis collection at the New York Botanical Garden there is a specimen collected in the Adirondacks by Dr. Rex measuring  $13 \times 8$  cm. Brandza reports it as attaining a spread of several square decimeters.

New Brunswick, New York, Ontario, Iowa, Washington; Sweden, Rumania, Japan.

## 2. *Alwisia* Berk. & Br.

Jour. Linn. Soc. 14 : 86. 1873.

Sporangia ellipsoidal, clustered, stipitate; dehiscence by the falling away of the upper part of the peridium disclosing a persisting pencil of capillitial threads.

A single species:

### *ALWISIA BOMBARDA* Berk. & Br.

Jour. Linn. Soc. 14 : 87. 1873.

Pl. XXI, Fig. 572.

1876. *Trichia fragilis* Rost., Mon. App. 39, in part.

1892. *Prototrichia bombarda* (Berk. & Br.) Massee, Mon. 128.

Sporangia gathered in clusters of four to eight, surmounting coalescent, or sometimes divergent stalks, rusty brown or pallid, the peridium evanescent above; the coalescing stalks forming, especially below, a clustered column, 2 mm. in height, equalling the sporangia, dull reddish brown in color; capillitium of rigid, tubular, generally simple threads, attaching above by delicate tips, below by a broader sometimes branching base, sometimes conjoined near the peridial wall, now and then at irregular intervals inflated slightly or sometimes bulbous, roughened by projecting spinules, one-third the diameter, brownish or yellow; spores reddish brown, faintly marked by reticulating bands over a large part of the surface,  $5-5.5 \mu$ .

This peculiar species looks at first very little like a myxomycete. The stiff projecting hairs of the capillitium look like hyphae but the spores and general structure are those of a myxomycete. Rostafinski was inclined to make a trichia of it because of the hair-like capillitium and

the markings on the threads; Massee believed he saw indistinct spiral markings, enough to suit at least the prototrichias. Lister would put it near the tubifers and in this is followed by Jahn. Torrend thinks of the dianemas, margaritas, etc., because of the simple capillitium attached above and below. Spore characters are probably the most reliable index. The partial reticulation suggests association with Tubifera and for the present it may find station there, as in the English monograph.

Rare. Known from Ceylon, Malay Peninsula, Sumatra and collected once in Jamaica.

### 3. *Liceopsis Torrend*

Bull. Soc. Port. Sc. Nat. 2 : 63. 1908.

Sporangia sessile or short-stipitate, subglobose or flattened, with fragile membranous walls. Occasionally separated, but usually densely gregarious, approaching a pseudo-æthaliium. Capillitium usually scanty, of branching threads arising from membranous expansions; sometimes lacking.

#### LICEOPSIS LOBATA (*Lister*) *Torrend*

Bull. Soc. Port. Sc. Nat. 2 : 63. 1908.

Pl. XVI, Figs. 401, 402.

1894. *Reticularia lobata* Lister, Mycetoza 161.

Sporangia closely clustered, angular by mutual pressure or occasionally solitary and subglobose, rarely short-stipitate, 0.4–1.1 mm. in diameter, rusty brown; peridium thin, slightly iridescent with a tendency to dehisce as a lid; sporangia when closely appressed forming a false æthaliium; capillitium scanty, rusty brown, of threads arising from brown membranes as in *Reticularia*; spores globose, 6–10  $\mu$  in diameter, coarsely reticulated over two-thirds of the surface, smooth or with fragmentary reticulations on the remainder. Plasmodium hyaline.

Our material is from Hillsboro, Oregon, collected by Mr. H. C. Gilbert (No. 944). Also reported from Washington. Apparently rare, but widely distributed in Europe; Japan.

### FAMILY RETICULARIACEÆ

Fructification either a true æthaliium or a pseudo-æthaliium in which the sporangial walls disappear before maturity; pulvinate, flat or somewhat plasmodiocarpous; pseudocapillitium thread-like or of perforated plates sometimes fraying out into threads; spores rusty, ochraceous or umber.



## KEY TO THE GENERA OF THE RETICULARIACEÆ

- a. Surface alveolar, the alveoli representing the caps of the sporangial units; from each cap four to six threads descend almost to the base..... 3. *Dictydiæthali*um
- a. Surface not alveolar..... b
- b. Pseudocapillitium of broad, perforated plates..... 1. *Enteridium*
- b. Pseudocapillitium of flat, irregular plates fraying out into threads..... 2. *Reticularia*

1. *Enteridium* Ehrenberg

Spreng. Jahrb. 1 : 55. 1818.

Fructification an æthaliium, the spore-mass permeated by plates with large openings, resulting in a pseudocapillitium forming an intricate network. Distinguished from *Reticularia* by the broad, perforated plates of the pseudocapillitium which do not fray out into marginal threads.

The fructification is presumably homologous with that of *Reticularia* and the reasons for regarding it as a true æthaliium are discussed in connection with the treatment of that genus.

## KEY TO THE SPECIES OF ENTERIDIUM

- a. Spores free..... b
- a. Spores clustered, rarely free..... c
- b. *Æthali*um pulvinate, reddish brown; spores brown in mass, reticulate..... 1. *E. rozeanum*
- b. *Æthali*um thin, broadly effused, dark olivaceous brown; spores brownish olive in mass, warted..... 5. *E. yabeanum*
- c. *Æthali*um plasmodiocarpous..... 2. *E. liceoides*
- c. *Æthali*um pulvinate..... d
- d. *Æthali*um olivaceous, of moderate size..... 3. *E. olivaceum*
- d. *Æthali*um very small, usually under 2 mm. in diameter; pale umber..... 4. *E. minutum*

1. *ENTERIDIUM* ROZEANUM Wingate

Proc. Ac. Nat. Sc. Phila. 1889 : 156

Pl. XV, Figs. 386, 387, 388.

1893. *Reticularia splendens* Morg., Jour. Cin. Soc. Nat. Hist. 15 : 137.1899. *Enteridium splendens* (Morg.) Macbr., N: A. Slime-Moulds 151.

*Æthali*um pulvinate, even or somewhat irregularly swollen or inflated, lobate or compound, covered by a thin, smooth, shining, brown cortex, 0.5–6 cm. in diameter; hypothallus white, often extending widely around the base; true capillitium none, the pseudocapillitium of thin, yellow-brown membranes forming the perforated sponge-like framework characteristic of the genus; spore-mass umber; spores by transmitted light pale yellow, about two-thirds of the surface reticulate, the remainder finely verrucose, 7–9  $\mu$ .

Very common. Often confused with *Reticularia lycoperdon*, from which it may be distinguished by its brown, never silvery, color, and the shining but uneven surface as well as by the distinctive pseudocapillitium. The plasmodium as it emerges from the wood is watery white, becoming pale pink or flesh color and slowly deepening to brown as the fructification forms.

In the Appendix to his Monograph, p. 33 (1876), Rostafinski applied the name *Reticularia* (?) *rozeana* to specimens developed by E. Roze, of Paris, on wood kept in a moist chamber.

This original collection seems to have disappeared. Later Wingate corresponded with Roze and received from him a small portion of a specimen collected in 1887 in the same locality in which the original specimen was found. On the basis of this evidence Wingate decided that the original European specimen was the same as our common American Enteridium, and published the name cited. The spores of the form described by Rostafinski are said to have "the entire surface uniformly warted" which is certainly not the case with the species under consideration. A. Lister (Jour. Bot. 29 : 263, 1891) describes and illustrates a form he calls *Reticularia rozeana* Rost., citing Rostafinski's description in the Appendix, with densely crowded sporangia, uniformly spinulose reticulate spores and plates fraying out into threads. In the third edition of the Mycetozoa this is referred to *Liceopsis lobata* Torrend, but the spores are referred to as "sharply and closely reticulated on two-thirds of their surface, faintly and loosely reticulated on the remaining third." This may be what Rostafinski had.

It is customary to speak of the perforated plates of the pseudocapillitium as degenerate sporangial walls. They may be, but Wilson and Cadman's study of *Reticularia* throws doubt on such assumption.

Southern Canada, northern and central United States, Washington, on decaying logs and stumps. Common, especially in the middle west. Also reported from Europe and Japan. Some of these reports, as suggested above, demand verification. Material received from Professor Brandza, collected in Moldavia, agrees with American collections.

## 2. ENTERIDIUM LICEOIDES G. List.

Guide to Br. Mycet. ed. 4. 48. 1919.

1896. *Enteridium olivaceum* Ehr. var. *liceoides* List., Jour. Bot. 34 : 211.

Æthelium plasmodiocarpous, usually curved, simple or branched, or forming a flattened network, dark brown or purple-brown, glossy;

wall purplish or brown, of two layers with granular matter between; pseudocapillitium of simple or forked columnar tubes connecting the upper and lower walls; spores pale brown or olivaceous, clustered, minutely warted on the exposed portion, 10–12  $\mu$ . Plasmodium rosy pink.

On coniferous wood, very rare in North America, if it occurs at all, the only collection so referred being a specimen somewhat intermediate between this species and *E. olivaceum*, collected by Dr. Farlow in New Hampshire. Not common in Europe.

### 3. ENTERIDIUM OLIVACEUM Ehrenb.

Spreng. Jahrb. 1 : 57. 1818.

Pl. XV, Figs. 389, 390, 391.

1825. *Reticularia versicolor* Fr., Syst. Orb. Veg. 147. 1825.

1829. *Reticularia olivacea* (Ehr.) Fr., Syst. Myc. 3 : 89.

1851. *Enteridium atrum* Preuss, Linnæa 24 : 142.

1866. *Reticularia applanata* Berk. & Br., Ann. Mag. Nat. Hist., 3 ser. 18 : 56.

1869. *Licea olivacea* (Ehr.) Fuckel, Symb. Myc. 338.

1873. *Licæthaliium olivaceum* (Ehr.) Rost., Vers. 4.

1888. *Enteridium rostrupii* Raunk., Bot. Tidssk. 17 : 48.

1888. *Enteridium macrosporum* Raunk., Bot. Tidssk. 17 : 48.

Æthaliium depressed, oval or elongate, 1 mm. to 3 cm. in greatest extent, 0.6–3 mm. thick; surface glossy, smooth, greenish or olivaceous brown; the pseudocapillitium composed of thin, pale olivaceous plates, widely perforate with circular openings; spores in clusters, six or more together, ovoid, distinctly warted at the wider end, pale olivaceous, 9–11  $\mu$ .

This, the type of the genus, is a very distinct species. Fries thought it might represent a less perfectly developed reticularia, and therefore wrote *Reticularia olivacea*, noting, however, the clustered spores and the lack of hypothallus.

New York, Washington, Oregon, California, South America; Europe.

### 4. ENTERIDIUM MINUTUM Sturgis

Mycologia 9 : 329. 1917.

Æthalia rounded or elongate, pulvinate, pale umber in color, seated on a broad membranous base, 1.5–2 mm. in diameter; wall wrinkled and usually marked with small scattered pits, pale yellow, membranous; pseudocapillitium membranous, minutely roughened, perforated with round openings, the margins of which show many free threads, or reduced to irregular, anastomosing strands arising from the base of the æthaliium, with membranous or net-like expansions at the angles

and with many delicate, free, pointed ends. Spores pale yellow, usually united in twos or threes, and ovoid or flattened on one side, when free, globose, very minutely spinulose,  $9.5\text{--}10.5\ \mu$ .

Colorado (Sturgis).

#### 5. ENTERIDIUM YABEANUM *Emoto*

Bot. Mag. Tokyo 46 : 170. 1932.

*Æthaliium* thin, expanded, irregular, 2–23 cm. in extent, 3–8 mm. thick; bister\* or natal-brown\*, covered by a thin brownish membrane and borne on a well-developed brown hypothallus; pseudocapillitium of brown, perforated plates; spores separate, olivaceous in mass, colorless under the lens, uniformly warted,  $6\text{--}7.5\ \mu$ . Plasmodium slate black.

Distinguished by its large size from all other species, from *E. rozeanum* by the spore characters, the thin fructification and the olivaceous coloring, from *E. olivaceum* by the large size and the smaller, unclustered spores.

Japan.

### 2. *Reticularia* Bull. emend. Rost.

Versuch 6. 1873.

1791. *Reticularia* Bull., Champ. 83, in part.

Fructification *æthalioid*, the pseudocapillitium consisting of membranous plates, branching and anastomosing in various ways, and generally giving rise at the sides and especially above to long, slender, flexuous threads, the whole forming a spongy mass; outer cortex silvery white, becoming copper colored; hypothallus well developed, white; spore-mass and threads umber or rusty brown.

It has been customary to speak of the frayed and perforated plates of the pseudocapillitium as degenerate sporangial walls. Wilson and Cadman, in their beautiful and detailed study of the single species included in this genus, demonstrate that this view is untenable. These authors regard the entire fructification as a single sporangium, but surely a sporangium formed from a dense aggregation of protoplasm representing many plasmodial strands is not completely homologous with what is called a sporangium in a trichia or a physarum. It may, on the other hand, easily be correlated with the fructification in *Fuligo* or *Lycogala*, and would seem to represent a true *æthaliium* as opposed to the pseudo-*æthalia* formed by the obvious coalescence of more or less clearly distinguishable sporangial units.

A single species:



RETICULARIA LYCOPERDON *Bull.*

Champ. 95. 1791.

Pl. XVI, Fig. 403.

- 1794. *Lycogala argentea* Pers., Roemer N. Mag. Bot. 1 : 87.
- 1801. *Lycogala turbinata* Pers., Syn. Meth. Fung. 158.
- 1801. *Lycogala punctata* Pers., Syn. Meth. Fung. 158.
- 1803. *Fuligo lycoperdon* (Bull.) Schum., Enum. Pl. Sæll. 2 : 193.
- 1804. *Reticularia argentea* (Pers.) Poiret, Lam. Encycl. 6 : 183.
- 1809. *Strongylium fuliginoides* Ditm., Schrad. n. bot. Jour. 3 : 3.
- 1829. *Reticularia umbrina* Fr., Syst. Myc. 3 : 87.
- 1908. *Reticularia jurana* Meylan, Bull. Soc. Vaud. Sc. Nat. 44 : 297.

*Æthaliium pulvinate*, 2-8 cm. broad, at first silvery white, later less lustrous, the cortex irregularly and slowly deciduous; hypothallus at first conspicuous as a white margin extending round the entire *æthaliium*, evanescent without, but persisting as a firm membrane beneath the spore-mass, pseudocapillitium abundant, tending to form erect central masses which persist long after the greater part of the fruit has been scattered by the winds; spore-mass umber, spores turbinate, by transmitted light pale, reticulate over about two-thirds of the surface, the remainder slightly warted, 8-9  $\mu$ .

Often confused with *Enteridium rozeanum*, the spores of the two forms being very much alike; the internal structure, however, is entirely different, and once compared, the two are thereafter easily distinguished at sight by external characters. The plasmodium is white, as noted by Bulliard. Fries cites with approval the words of Schweinitz,—“color corticis ab initio argenteus sericeo nitore insignis; sed deinde sordescit e griseo in subfuscum vergens.” Sometimes the surface does indeed shine as silver! The fructification appears to be isolated in each case; the entire plasmodium consumed in a single plasmodiocarp.

Both Rostafinski and the Lister monograph cite *Mucor lycogalus* Bolt. (Hist. Fung. 3 : 133, 1789) as a synonym. If this citation is warranted, Bolton's specific name should take precedence over that of Bulliard unless the latter, as thoroughly established, should be recognized as a *nomen conservandum*.

Not common in North America, but widely distributed, Maine to Ontario, Washington and California and south, Haiti, Argentina. In north temperate regions generally; apparently more frequent in Europe; Africa, Ceylon, Japan.

3. Dictydiæthaliu Rost.

Versuch 5. 1873.

1875. *Clathroptychium* Rost., Mon. 225.

Fructification a pseudo-æthaliu, the sporangia closely compressed in a single layer on an expanded base; lateral walls disappearing at maturity, the sporangia then represented by the angular, usually hexagonal tops, from the edges of each of which depend four to six simple threads, these reaching nearly to the base and there either free or united with each other; the united caps forming a continuous areolate surface; spores ochraceous or clay colored.

In 1873 Rostafinski applied the generic name here adopted, because he thought he discovered close relationships with Dictydium. In 1875, believing his first impressions erroneous, and desirous that the nomenclature might not at once mislead the student and perpetuate the memory of his mistake, the same author proposed the name *Clathroptychium*. However sensible the latter conclusion, it is plainly contrary to all rules of priority.

A single widely distributed species:

DICTYDIÆTHALIUM PLUMBEUM (*Schum.*) Rost.

Versuch 5. 1873.

Pl. XV, Figs. 392, 393, 394.

- 1803. *Fuligo plumbea* Schum., Enum. Pl. Sæll. 2 : 193.
- 1829. *Reticularia plumbea* (Schum.) Fr., Syst. Myc. 3 : 88.
- 1831. *Ostracoderma spadiceum* Schw., Trans. Am. Phil. Soc. II. 4 : 262.
- 1833. *Licea rugulosa* Wallr., Fl. Crypt. Germ. 2 : 345.
- 1845. *Licea applanata* Berk., Hook. Lond. Jour. Bot. 4 : 67.
- 1846. *Lycogala lenticulare* Dur. & Mont., Expl. Sci. Alg. 401.
- 1873. *Reticularia lurida* Berk. & Br., Jour. Linn. Soc. 14 : 82.
- 1873. *Licea cinnabarina* Berk. & Br., Jour. Linn. Soc. 14 : 86.
- 1873. *Dictydiæthaliu applanatum* (Berk.) Rost. ex Fuckel, Symb. Myc., Nachtr. 69.
- 1875. *Clathroptychium rugulosum* (Wallr.) Rost., Mon. 225.
- 1877. *Dictydiæthaliu dissiliens* Hazsl., (Esterr. Bot. Zeitschr. 27 : 85.
- 1879. *Clathroptychium cinnabarinum* (Berk. & Br.) Sacc., Michelia 1 : 545.
- 1892. *Clathroptychium berkeleyi* Massee, Mon. 53.

Fructification thin, flat, varying from a few mm. to 10 cm. in extent and 0.5–1 mm. in thickness, olivaceous, ochraceous brown, or reddish brown to dark plumbeous; surface areolate, the areolæ angular, usually hexagonal; sporangial walls lacking at maturity, but the sporangial units evidenced by the columnar structure and the threads depending from the areolæ nearly to the base; base marked in areas corresponding to the upper surface; true capillitium lacking; hypothallus silvery, usually prominent and often occupying a considerable

area around the fructification; spores ochraceous or clay colored in mass, rarely bright yellow, almost colorless by transmitted light, minutely roughened, 9–10  $\mu$ . Plasmodium at first pale, then pink or rose.

Recent studies by Miss Baker (1932) have shown that the sporangia are clearly delimited in the early stages, the walls disappearing before maturity, and that the threads are deposited on the inside of the sporangial walls and therefore are not true capillitial elements. The fructification is a pseudo-æthaliium which at maturity closely simulates a true æthaliium. The taxonomic position of the genus must be regarded as doubtful, perhaps close to Tubifera, but since it has long been customary to group it with Reticularia and Enteridium it may provisionally be retained in the family with them.

As noted, there is very great variation in the size and color of the fructification. Sometimes an entire plasmodium forms a single continuous and extensive sheet, at other times it is broken up into numerous smaller units. The var. *entoxanthum* (Berk.) G. List. (= *Reticularia entoxantha* Berk., Hook. Jour. Bot. 3 : 201, 1851) is distinguished from the typical form by its bright yellow spores, greater thickness and coarser threads; it occurs in Japan, the tropics and the southern hemisphere. Var. *cinnabarinum* (Berk. & Br.) Hiranuma, is a bright red form reported from Italy and Japan. We have such collections from Ohio and California. It is probably based, as Lister suggests, on incompletely matured collections.

The typical form is fairly common in the United States and Canada and is widely distributed in temperate and tropical regions in both hemispheres.

#### FAMILY LYCOGALACEÆ

Fructification an æthaliium; peridium membranaceous, tough, externally vesiculose with protoplasmic masses, gelatinous within; the pseudocapillitium attached to the peridium and consisting of irregular lobate or branching tubules, varying greatly in width and often flattened, and marked by numerous corrugations, irregular warts or bands; spores minute, ashen or pallid.

A single genus:

#### *Lycogala Micheli ex Adanson*

Fam. Pl. 2 : 7. 1763.

1753. *Lycoperdon* Linn., Sp. Plant. 1183, in part.

1818. *Diphtherium* Ehr., Sylv. Myc. Berol. 26.

With the characteristics of the family.

Micheli's description and figures, Nov. Plant. Gen. 216, 217, pl. 95, leave no doubt that this illustrious man had species of *Lycogala* be-

fore him when he described the genus. His fig. 1 no doubt portrays the third species in our present list. More recent writers, from Persoon down, have used Micheli's designation, but differed in regard to the limits to which the name should be applied. It is here used substantially as in 1729. Fries and after him Rostafinski make a mistake in quoting Retzius as writing *Lycogala*. Retzius wrote *Lycoperdon sessile* (Kongl. Vetenskaps Acad. Handling. för Ar 1769, 254).

## KEY TO THE SPECIES OF LYCOGALA

- a. Distinctly conical, small, not exceeding 3 mm. in height; diameter less than height. . . . . 4. *L. conicum*
- a. Subglobose or pulvinate, mostly larger; diameter equalling or exceeding height. . . . . b
- b. Usually 2-4 cm. in diameter; cortex thick, nearly smooth 3. *L. flavo-fuscum*
- b. Under 12 mm. in diameter; cortex thin, rough. . . . . c
- c. Mostly 3-10 mm. in diameter; cortex minutely roughened or warted. . . . . 1. *L. epidendrum*
- c. Mostly 2-5 mm. in diameter; cortex scaly. . . . . 2. *L. exiguum*

## 1. LYCOGALA EPIDENDRUM (L.) Fr.

Syst. Myc. 3 : 80. 1829.

Pl. XVI, Figs. 404, 405.

- 1753. *Lycoperdon epidendrum* L., Sp. Plant. 1184.
- 1770. *Mucor fragiformis* Schaeff., Fung. Bav. 4 : 132.
- 1772. *Mucor lycogala* Scop., Fl. Carn. ed. 2. 2 : 496.
- 1778. *Lycoperdon pisiforme* Jacq., Misc. Austr. 1 : 137.
- 1778. *Lycoperdon variolosum* Huds., Fl. Angl. ed. 2. 645.
- 1780. *Galoperdon epidendrum* (L.) Wiggers, Fl. Holsat. 109.
- 1783. *Lycoperdon chalybeum* Batsch, Elench. Fung. 155.
- 1794. *Lycogala miniata* Pers., Roemer N. Mag. Bot. 1 : 87.
- 1798. *Reticularia rosea* DC., Bull. Soc. Philom. 1 : 105.
- 1803. *Lycogala ferruginea* Schum., Enum. Pl. Sæll. 2 : 192.
- 1804. *Reticularia miniata* (Pers.) Poirer, Lam. Encycl. 6 : 184.
- 1804. *Reticularia punctata* Poirer, Lam. Encycl. 6 : 184.
- 1817. *Lycogala terrestris* Fr., Symb. Gast. 10.
- 1873. *Lycogala affine* Berk. & Br., Jour. Linn. Soc. 14 : 81.

Æthalia solitary or clustered, depressed-spherical, or, when crowded, irregular, olivaceous or blackish, minutely warted, 3-10 mm. in diameter, dehiscing irregularly, but more often near the apex; peridium thin, but tough and persistent, made up of numerous agglutinated tubules enclosing in their meshes peculiar cell-like vesicles; pseudo-capillitium parietal, consisting of long, branching, and anastomosing flattened tubules extended inwardly among the spores, everywhere marked by transverse wrinkles, ridges, and warts, the free ends of the ultimate branchlets rounded, concolorous with the spores; spore-mass,



when fresh, rosy, or ashen with a rosaceous or purplish tinge, becoming with age sordid or ochraceous; spores by transmitted light colorless, minutely roughened or reticulate, 5–6  $\mu$ .

This is not only a cosmopolitan species, but is no doubt the most common slime mold in the world. Found everywhere on decaying wood of all sorts, more particularly on that of deciduous trees. It has likewise been long the subject of observation. It is doubtless the *Fungus coccineus* of Ray, 1690, and the type of Micheli's genus of 1729. The different colors assumed, from the rich scarlet of the emerging plasmodium to the glistening bronze of the newly formed æthaliu, have suggested various descriptive names,—as *L. miniatum* Pers., *L. chalybeum* of Batsch, and *L. plumbea* Schum. The peridium is by some authors described as double. This is for description only. In structure the outer and inner peridium completely blend. The outer is predominantly vesiculose, the inner more gelatinous. For discussion of the microscopic structure see *L. flavo-fuscum*.

*Lycogala terrestre* Fr. appears to be a form of this species. In spores and capillitial threads it is indistinguishable; the difference is a matter of size, and to some extent, of the color of the wall. The specimens are a little larger, depressed and angular. The peridium is paler, smoother, though sometimes almost black, thin, ruptured irregularly. But the form and color of the peridium in the sporocarps of the older specimens vary much in response to external conditions; on a substratum affording scant nutrition the fructifications are minute; and in all cases, if maturity be hastened, the peridium responds in darker colors. Under more favorable conditions the wall is smoother and brighter.

Var. *tesselatum* Lister (in Penz., Myx. Buit. 77, 1898) is said to be very dark, with the cortical vesicles divided into numerous polygonal chambers.

Extremely common on dead wood throughout temperate and tropical regions.

## 2. *LYCOGALA EXIGUUM* Morgan

Jour. Cin. Soc. Nat. Hist. 15 : 134. 1893.  
Pl. XVI, Figs. 408, 409.

1913. *Lycogala epidendrum* (L.) Fr. var. *exiguum* (Morg.) List., Bot. Mag. Tokyo 27 : 415.

Æthalia small, 2–5 mm. in diameter, gregarious, globose, dark brown or black, sessile, minutely scaly, irregularly dehiscent; the peridium thin, the vesicles comparatively few, in irregular patches which are more or less confluent; capillitium as in preceding species, the tubules

slender and branching; spore-mass pale, ochraceous; spores by transmitted light colorless, almost smooth, 5–6  $\mu$ .

Found in the same situations as *L. epidendrum*. Recognizable by its gregarious habit, not crowded nor superimposed, small size and dusky color. The little spheres occur a dozen or more in a place, dark lead colored, shading to black, opening rather regularly at the top. It looks like a depauperate *L. epidendrum*, and is so regarded in the Lister monograph, but seems to be constantly collected. The same reference work describes the spores as "usually rosy-pink." Morgan described them as pale ochraceous and this agrees with the four collections in the Morgan herbarium.

Our specimens are from Ontario, Ohio, Wisconsin, Iowa, Missouri, Washington, British Guiana; Rumania. Widely distributed but not common.

### 3. LYCOGALA FLAVO-FUSCUM (*Ehr.*) *Rost.*

Versuch 3. 1873.

Pl. XVI, Figs. 406, 407.

1818. *Diphtherium flavo-fuscum* Ehr., Sylv. Myc. Berol. 27.

1829. *Reticularia flavo-fusca* (Ehr.) Fr., Syst. Myc. 3 : 88.

1895. *Lycogala repletum* Morg., Jour. Cin. Soc. Nat. Hist. 18 : 40.

1932. *Verrucosia corticola* Teng, Contr. Biol. Lab. Sc. Soc. China, Bot. ser. 7 : 124.

Æthalia solitary or sometimes two or three or more together, large, 2–4 cm. in diameter, spherical or spheroidal, purplish gray or brown, smooth, shining; peridium thick, in microscopic section showing two or three successive layers; capillitium of abundantly branching, irregular, transparent tubules, marked by numberless warts and transverse rings or wrinkles; spores in mass yellowish gray, by transmitted light colorless, faintly reticulate, 5–6.5  $\mu$ .

This, one of the largest and most striking of the slime molds, is generally mistaken for a puff-ball. It occurs on stumps and rotten logs of various sorts, in the Mississippi valley more often affecting stumps of *Acer saccharinum* L. The fructification, when solitary, is about the size of a walnut, though sometimes larger; when clustered, the individuals are smaller. The form depends largely upon the place in which the fruit is formed. The plasmodic mass is so large that its form is determined by gravity. Thus on the lower surface of a log raised a little distance from the earth the æthaliium is often pyriform. This fact did not escape Micheli. See Nov. Plant. Gen., pl. 95. The plasmodium is pale pink, soon becomes buff when exposed in fruiting, finally pallid or somewhat livid, and is outwardly changed into the stout tough

peridium. This consists of an intricate network of irregular gelatinous tubules enclosing within the meshes protoplasmic masses of pretty uniform size, 60–100  $\mu$ . Outwardly the protoplasmic vesicles predominate; inwardly the gelatinous tubules, which are, in some instances at least, continued toward the center of fructification to form the pseudocapillitium. The protoplasmic masses referred to respond to ordinary stains and are often broken into numberless small cells corresponding in size and appearance to ordinary spores.

Not common but widely distributed in the northern hemisphere, also reported from South America, South Africa and China. *L. repletum* Morg. seems to be merely an unusually large flat development of this species, with numerous short, free tubules. The type specimen is much broken, but so far as can be determined it differs in no significant respect from a typical representative of the present species.

Var. *argentea* Brandza, Ann. Sc. Univ. Jassy 7, 1914, is a very large form, said to attain the size of a large potato, arises from a brick-red plasmodium and is characterized by a silvery white peridium with both the pseudocapillitium characteristic of the genus and a fine, filamentous, branching and anastomosing true capillitium. Known only from Rumania, and rare there. It needs further study.

#### 4. LYCOGALA CONICUM Pers.

Syn. Meth. Fung. 159. 1801.

Pl. XVI, Figs. 410, 411.

1873. *Lycogala nitidum* Berk. & Br., Jour. Linn. Soc. 14 : 81.

1873. *Lycogala atropurpureum* Berk. & Br., Jour. Linn. Soc. 14 : 82.

1875. *Dermodium conicum* (Pers.) Rost., Mon. 284.

*Æthalia* scattered, sometimes two or three together, small, 2–4 mm. high, conical, sessile, pallid, grayish brown, marked by obscure black reticulations, opening regularly at the somewhat acuminate tip; peridium thin in structure, as in *L. epidendrum*, but more delicate; capillitium made up of abundant, slender, uniform threads almost smooth, simple, the free ends obtuse, taking origin in the cortex much as in *L. exiguum*; spores in mass ochraceous, by transmitted light colorless, minutely warted or faintly subreticulate, about 5  $\mu$ .

A very distinct and rare little species. Well described by Persoon, who also appears to have observed the plasmodium "primo rubra." The color of the mature form varies with age; at first somewhat purplish.

Rare. Pennsylvania, West Virginia, Ohio, Missouri, West Indies; Europe, Ceylon, Japan.

## ORDER TRICHIALES

Fructification sporangiate or plasmodiocarpous, the sporangia stalked or sessile, gregarious or closely crowded, limeless; capillitium of characteristically roughened or sculptured or rarely smooth threads, free or attached to the sporangium wall, isolated or combined into a net; spores generally bright colored, tinted with yellow, very rarely dark.

The distinguishing feature in this order is found in the peculiar sculpture of the capillitial threads. This is suggested by the tubules of *Lycogala*, though probably the resemblance is superficial only. The individual threads, as in *Trichia*, are called elaters, from their probable efficiency in spore dispersal.

As here limited, the order is substantially coextensive with the *Calonemeæ* of Rostafinski. The course of differentiation may be assumed to start with the *Dianemaceæ*, and to proceed through the *Perichænaceæ* to the *Arcyriaceæ*, and again, from the same starting-point, through *Prototrichia* to the *Trichiaceæ*.

## KEY TO THE FAMILIES OF THE TRICHIALES

- a. Capillitial threads slender, warted or spinulose, markings sometimes minute, threads rarely smooth. . . . . *b*
- a. Capillitial threads coarser, marked by spirals, cogs or rings. . . . . *c*
  - b. Peridium usually single; capillitial threads solid, transverse to the sporangial cavity, attached at one or both ends, or forming a net; markings minute or lacking. . . . . DIANEMACEÆ
  - b. Peridium double; capillitial threads hollow, free or attached at one end, papillose or spiny, rarely smooth. . . . . PERICHÆNACEÆ
- c. Capillitium a distinct net, attached below to sporangium wall; markings various but never in the form of spiral bands. . . . . ARCYRIACEÆ
- c. Capillitium netted or of short, free elaters, marked by distinct spiral bands, rarely nearly smooth. . . . . TRICHIACEÆ

## FAMILY DIANEMACEÆ

Sporangia pulvinate or plasmodiocarpous, sessile or substipitate; peridium usually single, thin, translucent, more or less iridescent; capillitium attached, of solid slender threads with minute markings usually arranged in one or more long spirals.

## KEY TO THE GENERA OF THE DIANEMACEÆ

- a. Dehiscence lobate; capillitial threads jointed; spores dark 1. *Listerella*
- a. Dehiscence irregular; capillitial threads not moniliform; spores pale. . . . . *b*
  - b. Capillitial threads coiled, hair-like, simple, attached at base. . . . . 2. *Margarita*
  - b. Capillitial threads not coiled. . . . . *c*



- c. Capillitium attached only to lower part of sporangium, branching and anastomosing to form a dense net. . . . . 3. *Lamprodermopsis*  
 c. Capillitial threads nearly straight, simple or scantily forked, attached to base and to sporangial wall. . . . . 4. *Dianema*

### 1. *Listerella Jahn*

Ber. Deutsch. Bot. Ges. 24 : 540. 1906.

Sporangia sessile, with lobate dehiscence; capillitium of jointed threads attached to the sporangial wall; spores dark.

A single species:

#### LISTERELLA PARADOXA *Jahn*

Ber. Deutsch. Bot. Ges. 24 : 540. 1906.

Pl. XVI, Figs. 412, 413, 414.

Sporangia sessile, pulvinate, 0.1–0.3 mm. in diameter, dull blackish brown, the wall granular except for the lines of dehiscence; capillitium scanty, of slender brownish, jointed threads 1–1.5  $\mu$  in diameter, attached to the sporangium wall; spores blackish brown in mass, pale brownish gray under the lens, with a distinct germinal region, faintly spinulose or nearly smooth, 7–8  $\mu$ .

A curious form of uncertain position, in appearance and spores suggesting *Licea*, but with an unique capillitium. The capillitial threads are jointed except near the points of attachment, the smaller end of each conical joint inserted in the larger end of the adjoining one, suggesting more than anything else the antennæ of certain insects.

On *Cladonia*. Germany, Russia.

### 2. *Margarita List.*

Mycetozoa 203. 1894.

Sporangia sessile, sometimes plasmodiocarpous; sporangium wall translucent; capillitium of simple or sparsely branched, hair-like, solid threads with occasional attachments to the sporangium wall.

A single species:

#### MARGARITA METALLICA (*Berk. & Br.*) *List.*

Mycetozoa 203. 1894.

Pl. XVI, Figs. 415, 416.

1838. *Physarum metallicum* Berk. & Br., Mag. Zool. and Bot. 1 : 49.

1876. *Cornuvia metallica* (Berk. & Br.) Rost., Mon. App. 35.

1910. *Margarita pictoviana* Moore, Proc. Nova Scotia Inst. Sc. 12 : 96.

Sporangia scattered or clustered, sessile, globose, flattened or plasmodiocarpous, 0.5–1 mm. in diameter, coppery iridescent; peridium

thin, opening above irregularly; capillitium of long, flexuous, coiling, simple or scantily branched solid threads, marked by a row of minute tubercles running around the thread in a long spiral; attachments to peridial wall infrequent; spores yellowish in mass, transparent under the lens, delicately verruculose, 10–12  $\mu$ .

Plasmodiocarpous forms have been described as var. *plasmodiocarpa* R. E. Fries and var. *intermedia* Meylan. Inasmuch as all gradations from a nearly globose sporangium to a plasmodiocarp may be found in a single fruiting, these names seem to be superfluous.

Rarely collected in North America but widely distributed and probably not uncommon: Nova Scotia, New Hampshire, New York, Iowa, Washington, Oregon, California, Chile. Also recorded from Europe, southern Asia and the Philippines.

### 3. *Lamprodermopsis* Meylan

Bull. Soc. Vaud. Sc. Nat. 46 : 168. 1910.

Sporangia sessile or stalked; peridium membranous, persistent, shining with metallic luster; columella lacking; capillitium arising from the base, composed of slender threads which fork and anastomose freely toward the surface, forming a dense net, not attached to the peridium and persisting after the peridium disappears; spores pallid.

The single species is included by Miss Lister in *Dianema*. As Meylan points out, the capillitial characters are so distinct as to imply an unwarranted extension of the limits of that genus. In peridial and capillitial characters it resembles *Lamproderma* and especially *Diacheopsis*, from which genera it is set off mainly by the pallid spores.

A single species:

#### LAMPRODERMOPSIS NIVALIS Meylan

Bull. Soc. Vaud. Sc. Nat. 46 : 56. 1910.

1925. *Dianema nivale* (Meyl.) G. List., Mycetozoa ed. 3. 254.

Sporangia separated, globose, sessile or stalked, 1–1.5 mm. in diameter, pale, with metallic luster; peridium thin, membranous, smooth, iridescent, long-persistent at the base; stalk, when present, concolorous, up to 1 mm. in height; columella lacking; capillitium arising from lower fourth of peridium, composed of filaments, more and more branching and anastomosing toward the surface, with numerous free ends; spores pale brownish, almost colorless under the lens, finely papillate, 10–12  $\mu$ .

Swiss Alps.

4. *Dianema Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 397.

Sporangia simple or plasmodiocarpous; capillitium composed of threads without noteworthy thickenings, running entirely across the sporangium, attached both to the base and to the opposite wall, not joined to form a network.

## KEY TO THE SPECIES OF DIANEMA

- |  |                         |
|--|-------------------------|
| a. Spores free. ....   | b                       |
| a. Spores clustered. ....                                      | d                       |
| b. Sporangia sessile or substipitate. ....                     | 1. <i>D. andersonii</i> |
| b. More or less plasmodiocarpous. ....                         | c                       |
| c. Pulvinate; dull red or iridescent; spores 8-10 $\mu$ . .... | 2. <i>D. harveyi</i>    |
| c. Broadly expanded; gray-brown; spores 6-9 $\mu$ . ....       | 3. <i>D. depressum</i>  |
| d. Wall cartilaginous, opaque; on wood. ....                   | 4. <i>D. corticatum</i> |
| d. Wall membranous, translucent; on lichens and hepatics. .... | 5. <i>D. repens</i>     |

1. *DIANEMA ANDERSONII* Morgan

in Macbride, N. A. Slime-Moulds ed. 2. 239. 1922.  
(as *D. andersoni*)

Sporangia globose, sessile or substipitate, 0.6-0.8 mm. in diameter, seated on a thin brownish hypothallus, the wall a thin surface somewhat thickened below and brownish at the base; capillitium arising out of the thickened base, the threads hyaline or pinkish, ascending, flexuous, simple, or branched a time or two, the extremities attached on all sides to the wall of the sporangium; spores free, globose, very minutely warted, pale, pinkish, 10-12  $\mu$ .

This species differs from *D. harveyi* Rex in the sporangiate rather than pulvinate or plasmodiocarpous fructification, and the uniform pinkish color of the wall and of the spores; the capillitial threads show occasional minute roundish tubercles as in *Didymium*; the spores are somewhat larger than in *D. harveyi*. Miss Lister, in the third edition of the English monograph, suggests that this is the same as *Lamprodermopsis nivalis* Meylan, which she transfers to *Dianema*. Careful comparison of the type specimen of *D. andersonii* with an authentic specimen of the *Lamprodermopsis*, communicated by Dr. Meylan, does not seem to support this view. The wall of the *Dianema* is rather densely charged with granular material while that of the *Lamprodermopsis* is thin and translucent. The capillitium of the former is scanty, slender and sparsely branched, and does not vary greatly in thickness, but the threads are united at the base as is usual in the genus; the capillitium of the latter is abundant, robust at the base, branching profusely, the ultimate branchlets being as

slender as those of the *Dianema*. The spores are quite different, those of the *Dianema* being large, averaging  $11\ \mu$ , and distinctly spinulose, the spines visible over the entire surface; the spores of the *Lamprodermopsis* are smaller, averaging about  $9\ \mu$  in our material, and the surface is covered with almost invisible spines apparently embedded in a gelatinous outer wall so that they are visible only at the margins.

British Columbia, Washington.

## 2. *DIANEMA HARVEYI* *Rex*

Proc. Acad. Nat. Sc. Phila. 1891 : 397.

Pl. XVI, Figs. 418, 419.

Sporangia gregarious, generally rounded or cushion-shaped, depressed, sessile, dull red or iridescent-bronze, 0.5–2 mm. in diameter; peridium thin, translucent, opening irregularly; capillitium of simple threads, not netted, but often forked two or three times, taut, running from base to top; spores free, yellow in mass, by transmitted light pale yellowish, spiny, 8–10  $\mu$ . Plasmodium white.

Rare. On dead wood, Maine, Colorado; Great Britain. Reported as locally abundant in Scotland.

## 3. *DIANEMA DEPRESSUM* *List.*

Mycetozoa 204. 1894.

Pl. XVI, Figs. 420, 421, 422.

1891. *Cornuvia depressa* List., Jour. Bot. 29 : 264.

Fructification pulvinate or plasmodiocarpous, flattened, 2–10 mm. wide, about 0.3 mm. thick, gray-brown, glossy; wall membranous, smooth or minutely reticulated, translucent, yellowish gray or lilac, marked on the inner side with the persistent ends of the capillitium; capillitium profuse, of pale, yellowish gray rigid threads, 0.5–2  $\mu$  thick, minutely papillose on one side, united above and below into pencil-like clusters, at length breaking away as an elastic web; spores free, in mass lilac-gray or drab, pale yellowish gray under the lens, closely reticulated over the greater part of the surface, the remaining part marked with broken or loose reticulation, 6–9  $\mu$ . Plasmodium white or rosy.

On wood. Rare in North America, known only from Washington and Oregon. Also Europe, Japan.

## 4. *DIANEMA CORTICATUM* *List.*

Mycetozoa 205. 1894.

Pl. XVI, Fig. 417; Pl. XXI, Fig. 562.

Sporangia sometimes flat-hemispheric, more often ill-defined, united in irregular, depressed, netted plasmodiocarps, generally dull brown;



peridium opaque, didermatous, capillitium of simple or rarely branching filaments, variously beaded or marked with spiral bands, lightly attached at either end, occasionally twisted together; spore-mass dull brown, the spores ellipsoidal, mostly clustered in groups of from two to six, colorless by transmitted light, smooth,  $10-15 \times 8-10 \mu$ . Plasmodium pink.

A curious, flat plasmodiocarp, sometimes an inch or more in length. It suggests *Hemitrichia serpula* prematurely dry. The Lister monograph describes the spores as minutely warted on the outer side. The spores of specimens received from Miss Lister have the appearance of roughness under the dry lens, but under oil immersion it may be seen that this is due to granules inside the spores, the walls being perfectly smooth.

Quebec, Alberta, Colorado, Washington; Europe, Australia.

#### 5. DIANEMA REPENS *G. Lister & Cran*

Mycetozoa ed. 3. 255. 1925.

Sporangia scattered, forming straight or curved, simple or branching plasmodiocarps, 0.3 mm. wide or more, dull purplish brown, with a wrinkled surface; sporangium wall membranous, almost colorless above, pale purplish brown below, with a thin outer layer of dark granular refuse matter; capillitium scanty, of brown threads  $2-3 \mu$  in diameter, broader at the base, more slender above, branching and anastomosing with wide membranous expansions; spores rosy pink in mass, adhering in clusters of 4 to 12, globose or oval, minutely warted on the exposed surface,  $10-11 \mu$ . Plasmodium rosy red.

Rare. On lichens and hepatics on living trees. Great Britain.

### FAMILY PERICHÆNACEÆ

Sporangia simple, plasmodiocarpous or forming pseudo-æthalia; capillitial threads slender, hollow, warted or spinulose or, in one genus, smooth, attached at one end; wall usually double. Sometimes united with the Arcyriaceæ, from which family, as here defined, the members of the present group are distinguished by the lack of a definite capillitial network, although the threads are sometimes more or less branched and form a loose, tangled mass.

#### KEY TO THE GENERA OF THE PERICHÆNACEÆ

- a. Capillitium smooth; sporangia clustered, often massed to resemble an æthaliium . . . . . 1. *Minakotella*
- a. Capillitium warted or spiny; fructifications sporangiate or plasmodiocarpous, often closely appressed . . . . . b

- b. Typically plasmodiocarpous; dehiscence irregular..... 2. *Ophiotheca*  
 b. Typically sporangiate, often densely massed forming a pseudo-  
 æthaliium; dehiscence typically circumscissile, rarely areolate 3. *Perichæna*

### 1. *Minakatella* G. List.

Jour. Bot. 59 : 92. 1921.

Sporangia sessile, clustered, more or less united into a pseudo-æthaliium; capillitium forming a coil of nearly simple, smooth, flattened tubular threads; spores reddish, spinulose.

A single species:

#### MINAKATELLA LONGIFILA G. List.

Jour. Bot. 59 : 92. 1921.

Sporangia sessile, subglobose, dull brick-red, 0.3–0.5 mm. in diameter, forming small heaped clusters, or confluent and forming a pseudo-æthaliium 2 mm. in diameter, with iridescent membranous walls; capillitium a coil of smooth, compressed, pale red threads, 1.5–3  $\mu$  across, sparingly branched and with a few free bulbous ends, bordered on one side by a low ridge; spores in mass dull venetian red, pale red by transmitted light, adhering in clusters of 8 to 14, spinulose, the markings more distinct on the exposed side, 10–11  $\mu$ .

Regarded by Miss Lister as related to *Perichæna*. The description suggests affinity with *Margarita*.

Rare. Known only from a single collection in Japan.

### 2. *Ophiotheca* Currey

Quart. Jour. Micr. Sc. 2 : 240. 1854.

1817. *Perichæna* Fr., Symb. Gast. 11, in part.

Fructification generally plasmodiocarpous, terete, bent or flexuous, often annular or cornuate, rarely globose or stalked, opening irregularly; peridium thin, not polished, covered more or less strongly with a distinct layer of scales or granules; capillitium of slender, loosely branching filaments, the surface rough to strongly spinulose; spores yellow.

Very close to *Perichæna*, with which it is often reunited. The irregular dehiscence and the stronger tendency toward plasmodiocarpous development constitute the distinctive characters.

#### KEY TO THE SPECIES OF OPHIOTHECA

- a. Peridium thin, single, membranous, dull gray or yellowish;  
 usually on herbaceous stems..... 1. *O. vermicularis*  
 a. Peridium firm, double, darker; usually on bark..... b  
 b. Brown or yellowish brown; capillitium minutely spinulose 2. *O. chrysosperma*  
 b. Chestnut brown or blackish; capillitium strongly spinulose 3. *O. wrightii*

## 1. OPHIOTHECA VERMICULARIS (Schw.) Massee

Mon. 134. 1892.

Pl. XVI, Figs. 423, 424, 425.

1832. *Physarum vermiculare* Schw., Trans. Am. Phil. Soc. II. 4 : 257.  
 1869. *Ophiotheca pallida* Berk. & Curt., Jour. Linn. Soc. 10 : 350.  
 1873. *Ophiotheca umbrina* Berk. & Curt., Grev. 2 : 68.  
 1873. *Licea reticulata* Berk. & Br., Jour. Linn. Soc. 14 : 86.  
 1875. *Perichæna variabilis* Rost., Mon. 295.  
 1875. *Perichæna friesiana* Rost., Mon. 296.  
 1876. *Perichæna vermicularis* (Schw.) Rost., Mon. App. 34.  
 1876. *Perichæna reticulata* (Berk. & Br.) Rost., Mon. App. 35.  
 1892. *Ophiotheca reticulata* (Berk. & Br.) Massee, Mon. 133.

Plasmodiocarp very slender, terete, elongate, flexuous, reticulate or annular, dull gray, yellowish or of neutral tint; peridium thin, translucent, but with a delicate granular outer coating; capillitium of slender threads, frequently branched, warted and usually minutely spinulose; spore-mass ochraceous yellow; spores by transmitted light pale yellow, minutely roughened, 10-14  $\mu$ .

Perhaps common, but seldom collected, probably overlooked on account of protective coloration; the color is about that of the habitat, the weathered surface of dead herbaceous stems and roots. Not infrequent on dead corn stalks. Differs from other species of the genus in having smoother capillitium, for which reason Rostafinski calls the present species *Perichæna vermicularis*.

New England, New Jersey, South Carolina, Ontario, Ohio, Iowa, Colorado, Oregon, Bolivia. North temperate regions generally, also Ceylon, Malay Peninsula, Southern Nigeria.

## 2. OPHIOTHECA CHRYSOSPERMA Currey

Quart. Jour. Micr. Soc. 2 : 240. 1854.

Pl. XVI, Figs. 426, 427, 428.

1867. *Trichia curreyi* Crouan, Fl. Finist. 16.  
 1875. *Cornuvia circumscissa* (Wallr.) Rost., Mon. 290.  
 1881. *Hemiarcyria melanopeziza* Speg., Ann. Soc. Cient. Argent. 10 : 257.  
 1892. *Ophiotheca circumscissa* (Wallr.) Massee, Mon. 131.  
 1894. *Perichæna chrysosperma* (Currey) List., Mycetozaa 196.  
 1904. *Perichæna variabilis* Rost. var. *pedata* List., Jour. Bot. 42 : 139.  
 1911. *Perichæna corticalis* (Batsch) Rost. var. *affinis* List., Mycetozaa ed. 2. 251.

Plasmodiocarp elongate, bent and curved in various ways, sometimes spherical and stalked, often annular or even reticulate, yellowish or ochraceous brown, opening irregularly; peridium thin, with yellowish outer layer; capillitium rather abundant, of slender threads, sparingly

branched and minutely but distinctly spinulose; spore-mass yellow; spores by transmitted light pale, minutely but distinctly verrucose, 7-9  $\mu$ . The plasmodium is said by Lister to be "pale brown, grey or pink."

Occurs on the inner bark of deciduous trees, especially of oak. Not common.

While this is doubtless *Cornuvia circumscissa* (Wallr.) of Rostafinski's monograph, it is uncertain to what Wallroth referred. Lister suggests *Perichæna depressa*. Rostafinski's other citations are equally dubious. Currey's figures and description alone merit recognition.

Ohio, Iowa, Tennessee, Ontario, West Indies, British Guiana, Argentina; Europe, Ceylon, Java, Japan.

### 3. OPHIOTHECA WRIGHTII Berk. & Curt.

Jour. Linn. Soc. 10 : 349. 1869.  
Pl. XVII, Figs. 429, 430, 431, 432.

1876. *Cornuvia wrightii* (Berk. & Curt.) Rost., Mon. App. 36.

1911. *Perichæna chrysosperma* (Currey) Lister, Mycetozaa ed. 2. 248, in part.

Plasmodiocarp bent or short-flexuous, often arcuate or completely annular, sometimes globose, dark chestnut brown or black, opening irregularly or sometimes circumscissile, especially in the sporangiate fruitings; peridium thin, brittle, translucent, covered without by a rather dense layer of brown or brownish black scales; capillitium of long, sparingly branched threads furnished with projecting rough spines remarkable for their length, up to twice the diameter of the thread; spores yellow, minutely but distinctly warted, 9-10  $\mu$ . Plasmodium dull lead-gray, becoming yellowish brown or pinkish before fruiting.

This is the common species everywhere on the inner side of the bark of fallen trees, *Ulmus*, etc. It is readily distinguished at sight by the peculiar annular, looped, and U-shaped plasmodiocarps, with their dark umbrine or blackened surface. From the preceding it is especially distinguished by the spinulose capillitium and slightly larger spores.

Not rare. New England, New York, Pennsylvania, Ohio, Wisconsin, Iowa, Puerto Rico; Europe.

### 3. *Perichæna Fries*

Symb. Gast. 11. 1817.

Sporangia typically flattened, sometimes small and roundish, more often larger, polygonal by mutual interference or irregular; peridium



thickened outwardly by a dense reddish or brownish layer of scales, dehiscing by circumscission, cutting off a distinct lid, or, in one species, by areolæ; capillitium often scant, of slender, warted, yellowish threads, sometimes attached to the upper wall; spores yellow, oval or spherical.

The regular, circumscissile dehiscence is the characteristic mark which distinguishes this genus, as here presented, from *Ophiotheca*. In general, the tendency toward a plasmodiocarpous development is less marked and the capillitium is less strongly sculptured. Two old-world tropical species, placed here by their authors, are characterized by irregular dehiscence.

KEY TO THE SPECIES OF *PERICHÆNA*

- |   |                          |
|---|--------------------------|
| a. Dehiscence circumscissile.....   | b                        |
| a. Dehiscence not circumscissile.....                                     | e                        |
| b. Sporangia greatly flattened; crowded.....                              | c                        |
| b. Sporangia hemispherical or subglobose; less crowded or gregarious..... | d                        |
| c. Individual sporangia 0.5-1 mm. or more in diameter.....                | 1. <i>P. depressa</i>    |
| c. Individual sporangia 0.1-0.4 mm. in diameter.....                      | 2. <i>P. quadrata</i>    |
| d. Chestnut brown; spores 10-12 $\mu$ .....                               | 3. <i>P. corticalis</i>  |
| d. Gray or canescent; spores 12-15 $\mu$ .....                            | 4. <i>P. marginata</i>   |
| e. Dehiscence areolate; purplish black.....                               | 5. <i>P. tessellata</i>  |
| e. Dehiscence irregular.....  | f                        |
| f. Plasmodiocarpous; salmon pink.....                                     | 6. <i>P. microspora</i>  |
| f. Sporangiate, stalked; purplish.....                                    | 7. <i>P. pulcherrima</i> |

1. *PERICHÆNA DEPRESSA* *Libert*

Fl. Crypt. Ard. fasc. 4, No. 378. 1837.

Pl. XVII, Figs. 433, 434.

1842. *Stegasma depressum* (Lib.) Corda, Icones 5 : 58.  
 1873. *Perichæna artocreas* Berk. & Rav., Grev. 2 : 68.  
 1873. *Perichæna irregularis* Berk. & Curt., Grev. 2 : 68.  
 1874. *Stegasma australe* Ces., Hedwigia 13 : 186.  
 1876. *Perichæna marginata* Berk. & Br., Jour. Linn. Soc. 15 : 84, non Schw.  
 1887. *Hemiarcyria applanata* Cooke & Mass., Grev. 16 : 20.  
 1888. *Perichæna australis* (Ces.) Berl., in Sacc., Syll. 7 : 422.  
 1892. *Perichæna applanata* (Cooke & Mass.) Masee, Mon. 116.  
 1892. *Ophiotheca irregularis* (Berk. & Curt.) Masee, Mon. 132.

Sporangia sessile, applanate, crowded, polygonal by mutual contact, fuscous to chestnut brown, shining, opening by a definite lid; spore-mass and capillitium yellow, the capillitium well developed, almost smooth, of slender yellow threads of various widths; spores minutely warted, 10-12  $\mu$ .

Easily recognized by the peculiar polygonal, depressed-flattened sporangia and consequent shallow spore-cases in which lie the yellow spores and scanty capillitium.

In the crevices and on the inside of bark of fallen logs of various sorts, walnut, maple, etc.

Not rare but not commonly collected. Probably over the whole wooded region of the continent, and widely distributed in temperate and tropical regions generally.

## 2. PERICHÆNA QUADRATA *Macbride*

N. A. Slime-Moulds ed. 2. 243. 1922.

Pl. XVII, Figs. 435, 436, 437, 438.

Sporangia very small, 0.1 to 0.4 mm. in diameter, crowded, polygonal, depressed but convex, smooth, bright rufous or brown to nearly black; peridium rather thick, yellow within and minutely papillose, the dehiscence circumscissile; capillitium usually scanty, of slender, sparingly branched filaments, 2–3  $\mu$  thick, the surface minutely roughened; spore-mass yellow; spores by transmitted light pale yellow, minutely spinulose, 9–11  $\mu$ . Plasmodium yellow, then maroon.

Differs from the preceding by the much smaller size of the sporangia and the different color and habit. The sporangia, while depressed, still maintain considerable rotundity; they are occasionally quite spherical, and then of very uneven size, hardly in contact. In some cases the plasmodium before maturing seems to assume the form of a plasmodiocarp, which, by transverse fission at intervals, forms the curious four sided conceptacles. At other times the plasmodium assumes the shape of a flat cushion or plate, which then subdivides into minute polygonal segments. This form has long been known to collectors, and has often been distributed as *P. irregularis* Berk. & Curt. Lister assures us that Berkeley's type "is typical *P. depressa*."

Not common. Pennsylvania, Ohio, Illinois, Missouri, Iowa.

## 3. PERICHÆNA CORTICALIS (*Batsch*) *Rost.*

Mon. 293. 1875.

Pl. XVII, Figs. 439, 440.

1783. *Lycoperdon corticale* Batsch, Elench. Fung. 155.

1791. *Sphaerocarpus sessilis* Bull., Champ. 132, pl. 417, fig. 5.

1794. *Trichia fusco-atra* Sibth., Fl. Oxon. 407.

1796. *Trichia gymnosperma* Pers., Obs. Myc. 1 : 63, pl. 6, figs. 1, 2.

1797. *Trichia circumscissa* Schrad., Nov. Gen. Pl. 19.

- 1801. *Licea circumscissa* (Schrad.) Pers., Syn. Meth. Fung. 196.
- 1803. *Physarum luteo-album* Schum., Enum. Pl. Sæll. 2 : 199, *non* Lister.
- 1808. *Tubulina circumscissa* (Schrad.) Poiret, in Lam. Encycl. 8 : 131.
- 1817. *Perichæna abietina* Fr., Symb. Gast. 11.
- 1817. *Perichæna populina* Fr., Symb. Gast. 12.
- 1875. *Perichæna fusco-atra* (Sibth.) Rost., Mon. 294.
- 1879. *Perichæna rostafinskii* Karst., Bidr. Kann. Finl. Nat. 31 : 130.
- 1889. *Oligonema broomei* Massee, Jour. R. Micr. Soc. 346.

Sporangia sessile, gregarious, flattened, hemispherical; peridium simple, opening by a lid; dehiscence circumscissile, the upper part chestnut brown, the lower almost black; capillitium feebly developed, smooth, attached to the lid and usually coming away with it, bringing the brilliantly yellow spore-mass, and leaving a delicate, shining cupule adherent to the substratum; spores yellow, faintly warted over about two-thirds the surface, 10–12  $\mu$ .

On and under the bark of dead trees of various species, especially elms and poplars.

A very handsome little species occurring rarely with us, or perhaps overlooked by virtue of its protective coloration. Found sometimes on the inner side of the bark where the latter has separated, but not yet wholly parted company with the wood. In such situations the tiny sporangia are so nearly the color of the moist substratum as to escape all but the closest scrutiny. The dehiscence is very remarkable, characteristic, beautiful. Black, brown, chestnut and gold are harmoniously blended in the opening coffers. Prior to maturity the future line of fission is plainly indicated by the difference in color.

This is clearly the species found by Batsch "*ligni demortui putridi in interiore corticis pagina*." Bulliard has also described and figured the species as *Sphærocarpus sessilis*. The capillitium is nearly smooth; the spores are only slightly roughened by minute warts.

Apparently not common. Ontario, Wisconsin, Iowa, Missouri, South Dakota, New Mexico; Europe, South Africa, Ceylon, Malay Peninsula.

Var. *liceoides* (Rost.) Lister, Mycetoza ed. 2. 251. Very small, 0.1–0.5 mm. in diameter; sporangia subglobose or bolster-shaped, nut-brown or shining yellow, dehiscence irregular, granular deposits scanty or lacking; capillitium scanty or none, of nearly smooth threads, rarely forming a network. Based on *Perichæna liceoides* Rost., Mon. 295 (= *Licea pannorum* Cienk. *non* Wallr., Pringsh. Jahrb. Bot. 3 : 407, 1863; *Lachnobolus pygmaeus* Zukal, Oesterr. Bot. Zeitschr. 53 : 136, 1893). Specimens not seen. From the description quite distinct, and closer to *Oligonema* by virtue of the irregular dehiscence, but intermediate collections are said to occur.

4. *PERICHÆNA MARGINATA Schw.*

Trans. Am. Phil. Soc. II. 4 : 258. 1832.

Pl. XVII, Figs. 441, 442.

Sporangia depressed, globose, polygonal as they become approximate or crowded, hoary-canescens, sessile; peridium rather thick, persistent, circumscissile in dehiscence, covered without by minute whitish scales, within punctate by the imprint of the spores; hypothallus distinct, white; capillitium scant or none; spores in mass dull yellow, by transmitted light pale, nearly smooth, 12–15  $\mu$ .

Lister, following Rostafinski, includes this form with the preceding. The differences between the two forms are, it seems to us, sufficient to make convenient their separation as by Schweinitz. Apart from the peculiar incrustation in the present species, the larger spores, and especially the peculiar white hypothallus, are distinctive. The method of dehiscence is also different. In *P. corticalis* the line of cleavage before spore dispersal is indicated by a definite band surrounding the sporangium. Nothing similar appears in the gray specimens of the present form, although the dehiscence is quite as certainly circumscissile. The habitat in American specimens is the outer surface of the bark, which causes the species generally, by protective coloration, to be overlooked.

Not common. Pennsylvania, Ohio, Missouri.

5. *PERICHÆNA TESSELLATA G. List.*

Jour. Bot. 69 : 298. 1931.

Sporangia scattered, globose, purplish black, 0.1–0.5 mm. in diameter, the dark outer wall breaking up into polygonal areolæ and exposing the shining, translucent inner wall; capillitium composed of slender yellow tubular threads marked with minute warts and constrictions; spores bright yellow, closely and minutely warted, 9–10  $\mu$ .

Allied to *P. depressa* Lib. from which it differs in the scattered, globose sporangia and the areolate dehiscence.

Japan.

6. *PERICHÆNA MICROSPORA Penz. & List.*

Myx. Buit. 76. 1898.

Plasmodiocarps slender, short, long or net-like, 0.25–0.35 mm. broad, salmon pink, glossy; wall single, membranous, smooth, yellowish, with granular matter near the base; capillitium a network of slender, yellowish pink, minutely spinulose threads, 1.5–2  $\mu$  in diameter, regularly constricted at intervals of 1–2  $\mu$ , more or less attached to the



sporangium wall; spores pinkish yellow in mass, pale yellow by transmitted light, closely and minutely spinulose, 6–8  $\mu$ .

Specimens not seen, but related to *Ophiotheca vermicularis* by the character of the sporangium wall and clearly belonging in *Ophiotheca* if that genus is to be maintained.

Rare. Known only from Java and Ceylon.

#### 7. PERICHÆNA PULCHERRIMA *Petch*

Ann. R. Bot. Gard. Perad. 4 : 305. 1909.

Sporangia scattered and stalked, or clustered and almost sessile on an irregular hypothallus, globose, 0.5 mm. in diameter, glossy purple-red or purple-brown; sporangium wall of two closely adhering layers, the outer rather stout, purplish red, the inner hyaline; dehiscence irregular; stalks 0.1–0.3 mm. high, red-brown, furrowed, containing refuse matter; capillitium a loose network of reddish brown threads, marked with warts and spines, 3–4  $\mu$  in diameter, with few rounded free ends and few attachments to the sporangial walls; spores reddish brown in mass, paler by transmitted light, spinulose, 15–17  $\mu$  in diameter.

In spite of the tendency to form separate sporangia, the irregular dehiscence and spiny capillitium would seem to ally this species with *Ophiotheca* rather than with *Perichæna*.

Rare. Known only from Ceylon.

### FAMILY ARCYRIACEÆ

Sporangiate, rarely plasmodiocarpous; sessile or stalked; capillitium of hollow tubes, united into a network and attached below; threads marked with spines, warts, cogs or rings, but not spirals.

#### KEY TO THE GENERA OF THE ARCYRIACEÆ

- a. Sessile or plasmodiocarpous; capillitium flaccid, bearing complete rings. . . . . 4. *Cornuvia*
- a. Sporangiate, stalked or sessile; capillitium not marked with rings. . . . . b
- b. Capillitium not elastic; peridium persistent. . . . . 1. *Lachnobolus*
- b. Capillitium elastic; peridium not persistent. . . . . c
- c. Capillitium without hamate branches. . . . . 2. *Arcyria*
- c. Capillitium with hamate branches. . . . . 3. *Heterotrichia*

#### 1. *Lachnobolus* *Fr.*

Fl. Scand. 356. 1835.

Sporangia distinct, often crowded; wall single, membranous, fugacious above, persistent below as an irregular, shallow cup; capillitium

in the form of a network of threads marked with cogs, warts or reticulations, attached at numerous points to the sporangial wall, *not elastic*; spores pallid, pinkish or yellowish.

Close to *Arcyria*, of which it was originally designated a "tribe" (Syst. Myc. 3 : 177), but distinguished by its non-elastic capillitium and the more persistent, attached peridium.

#### KEY TO THE SPECIES OF LACHNOBOLUS

- a. Sporangia sessile, crowded or heaped. . . . . 1. *L. congestus*
- a. Sporangia stalked, gregarious or scattered. . . . . b
- b. Yellowish or ashy; stipe about equal to height of sporangium; on burs and fallen catkins of *Castanea*. . . . . 2. *L. globosus*
- b. Rosy or copper colored, fading to brownish or ochraceous; stipe short, sometimes almost lacking. . . . . 3. *L. occidentalis*

#### 1. LACHNOBOLUS CONGESTUS (Somm.) List.

Mycetozoa ed. 2. 246. 1911.  
Pl. XVII, Figs. 443, 444, 445.

- 1826. *Physarum congestum* Somm., Fl. Lapp. 241.
- 1827. *Arcyria circinans* Fr., Stirp. Femsj. 83.
- 1829. *Perichaena congesta* (Somm.) Fr., Syst. Myc. 3 : 192.
- 1833. *Licea congesta* (Somm.) Wallr., Fl. Crypt. Germ. 2 : 345.
- 1849. *Lachnobolus circinans* Fr., Summ. Veg. Scand. 457.
- 1873. *Lachnobolus sauteri* Rost., in Fuckel, Symb. Myc. Nachtr. 76.
- 1876. *Arcyria congesta* (Somm.) Berk. & Br., Ann. Mag. Nat. Hist. IV. 17 : 140.
- 1885. *Lachnobolus incarnatus* (Alb. & Schw.) Schroet., in Cohn, Krypt. Fl. Schles. 3 (1) : 110.

Sporangia globose, sessile, 0.4–0.8 mm. in diameter, pale copper colored, fading to ochraceous; hypothallus absent or present only as a glistening, fugacious membrane over the substratum; peridium irregularly fugacious above, persistent below as a shallow, irregular cup, opalescent, marked with warts and vein-like ridges; capillitium a network of much branched threads, mostly 3–4  $\mu$  thick, but in places inflated to 5–6  $\mu$ , not elastic or only very slightly so, marked with cogs and faint, irregular reticulations, or merely rugulose, with spines, ochraceous in mass, pallid by transmitted light; spores subglobose or angled by mutual pressure, pale pink or ochraceous in mass, pallid by transmitted light, smooth save for a few scattered warts, 7–8  $\mu$ .

*Lachnobolus circinans* Fries is described as rusty red, with rust colored spores. In the nearly related genus *Arcyria*, several reddish species fade readily to ochraceous or brownish, and the color seems scarcely sufficient ground to exclude Fries' collections.

Rare in North America. Ontario, New York, Iowa, Oregon. Not common in Europe.

2. *LACHNOBOLUS GLOBOSUS* (Schw.) Rost.

Mon. 283. 1875.

Pl. XVIII, Figs. 466, 467.

1822. *Arcyria globosa* Schw., Schrift. Naturforsch. Ges. Leipzig. 1 : 38.1829. *Craterium globosum* (Schw.) Fr., Syst. Myc. 3 : 154.1894. *Arcyria albida* Pers. var. *globosa* (Schw.) List., Mycetozoa 186.

Sporangia globose, stipitate, 0.5–1.5 mm. tall, cinereous to pale yellowish, solitary or in small clusters; stipe 0.3–0.7 mm. long, concolorous, hollow, filled with spore-like cells; peridium very fragile, colorless, papillose or almost smooth, evanescent above, leaving the cup-like lower portion as a calyculus; capillitium pallid, not at all or only slightly elastic, the threads 3.5–4.5  $\mu$  in diameter with nodes only slightly swollen, seldom over 10  $\mu$  across, densely warted, connected with the peridium by frequent arms; spores pallid, very minutely spinulose, with a few scattered warts, globose or slightly angled as a result of mutual pressure, 7–8.5  $\mu$ .

Rostafinski placed this species in the genus *Lachnobolus* because of the non-elastic capillitium. Miss Baskerville (1932), after studying the abundant material in the University of Iowa herbarium, concluded that its affinities are with *Arcyria*, where it is placed in the English monograph.

Eastern United States, usually on fallen catkins and burs of *Castanea dentata* and *C. pumila* and coextensive in range with these hosts. Also reported from Washington on an alder catkin and from Ceylon on dead leaves.

3. *LACHNOBOLUS OCCIDENTALIS* Macbr.

N. A. Slime-Moulds 188. 1899.

Pl. XVIII, Figs. 476, 477.

1892. *Lachnobolus incarnatus* (Alb. & Schw.) Schroet. ex Macbr., Bull. Lab. Nat. Hist. Iowa 2 : 126.1911. *Arcyria occidentalis* (Macbr.) List., Mycetozoa ed. 2. 245.

Sporangia globose to ellipsoidal, sessile or short-stipitate, 0.5–2.5 mm. tall, at first rosy, then brown or ochraceous, crowded and often more or less distorted, but not heaped; stipe 0–1.5 mm. long, concolorous to dark red-brown, hollow, filled with spore-like cells; peridium shining with a metallic luster, very fragile in upper portion, often with the sides thickened into four or five lobes where it has been in contact with neighboring sporangia, these lobes remaining after the more fragile upper part has disappeared; calyculus below the lobes ribbed or fluted, with frayed edges where the lobes have not formed

or where they have been broken off, lobes and the lower calyculus often darker than the rest of the peridium; inside of peridium marked with warts which are sometimes elongated into ridges; capillitium inelastic, sometimes rather scanty, the threads 3-4  $\mu$  wide, warted, ridged or rarely imperfectly ringed or spiralled, with inflations 7-25  $\mu$  across; spores very minutely spinulose, with a few scattered warts, 7-8  $\mu$ . Plasmodium white, then rosy.

Miss Baskerville, who studied this species carefully, agrees with Mr. Lister that its affinities are with *Arcyria* rather than with *Lachnobolus*.

Maine to Manitoba, south to Missouri and Nebraska.

## 2. *Arcyria Wiggers*

Fl. Holsat. 109. 1780.

Sporangia ovoid, cylindric or globose, stipitate or almost sessile; peridium thin, evanescent to near the base, the lower part persisting as a calyculus; stipe variable, often packed with free cell-like vesicles resembling spores, but larger; capillitium an elastic network, the tubules adorned with warts, spinules, half-rings or cogs, but without spiral bands or free extremities, usually attached below, to the interior of the stipe or to the calyculus.

Micheli, of course, discovered the arcyrias, put them in two genera and several species, which we may only dimly recognize. Persoon first saw distinctly the outlines of the genus as now understood and adopted the name given by Hill (Gen. Nat. Hist. 2:47) in his curiously prolix description of certain species, probably partly of the genus *Arcyria*, partly *Stemonitis*, and first used after 1753 by Wiggers.

### KEY TO THE SPECIES OF ARCYRIA

- |  |                         |
|--|-------------------------|
| a. Capillitium almost or quite free from the calyculus. . . . .                                | b                       |
| a. Capillitium attached to the calyculus. . . . .  | i                       |
| b. Mature capillitium far expanded, drooping. . . . .  | c                       |
| b. Mature capillitium short, not drooping, though sometimes procumbent. . . . .                | f                       |
| c. Sporangia dusky, with gray to reddish tints. . . . .  | d                       |
| c. Sporangia yellowish or greenish. . . . .  | e                       |
| d. Large, 6-12 mm., tawny gray, spores 7-8 $\mu$ . . . . .                                     | 1. <i>A. magna</i>      |
| d. Of medium size, 4-6 mm., dull crimson, sometimes<br>vermillion, spores 8-10 $\mu$ . . . . . | 2. <i>A. ærstedtii</i>  |
| e. Pale yellow or buff; calyculus broad. . . . .   | 3. <i>A. nutans</i>     |
| e. Yellowish green; calyculus narrow. . . . .  | 4. <i>A. virescens</i>  |
| f. Obovate or pyriform; olivaceous with yellow and reddish<br>tints. . . . .                   | 5. <i>A. versicolor</i> |
| f. Oval or cylindrical; reddish or flesh colored, at length<br>sordid. . . . .                 | g                       |



g. Spores 7-8 $\mu$ .....	6. <i>A. incarnata</i>
g. Spores 10-12 $\mu$ .....	h.
h. Capillitium with numerous node-like expansions.....	7. <i>A. nodulosa</i>
h. Capillitium without node-like expansions.....	8. <i>A. ferruginea</i>
i. Sporangia globose or subglobose; capillitium only slightly elastic.....	j
i. Sporangia ovate or cylindrical; capillitium more elastic.....	k
j. Capillitium marked with blunt spines, warts and transverse bands.....	9. <i>A. pomiformis</i>
j. Capillitium with close-set rings.....	10. <i>A. annulifera</i>
k. Pale bluish green becoming greenish drab.....	11. <i>A. glauca</i>
k. Cinereous or yellowish.....	l
k. Red or flesh colored.....	m
l. Sporangia separate.....	12. <i>A. cinerea</i>
l. Sporangia clustered.....	13. <i>A. digitata</i>
m. Flesh colored.....	14. <i>A. carnea</i>
m. Rose colored, small; stipe short.....	15. <i>A. insignis</i>
m. Red, weathering to brown, robust; stipe long.....	16. <i>A. denudata</i>

### 1. ARCYRIA MAGNA *Rex*

Proc. Acad. Nat. Sc. Phila. 1893 : 364.

Pl. XVII, Figs. 446, 447, 448, 449.

Sporangia densely aggregated, forming clusters of greater or less extent, sometimes reaching several centimeters in either direction, tawny gray or ashën, cylindric, narrowing a little above, when expanded reaching a length of 5-10 mm. or more, stipitate; peridium iridescent, evanescent except the small shallow cup-like base, the calyculus; stipe 1 mm. long, weak, pale brown or reddish, tubular, the channel filled with plasmodic masses; capillitium gray or drab, very slightly attached to the bottom of the calyculus, far expanded, forming a loose-meshed net, the threads regular, cylindric, coarsely sculptured with rings, half-rings, cogs, spines, etc.; spores in mass dull gray, drab, under the lens colorless, minutely spinulose or papillate, with few papillæ, 6-8  $\mu$ .

This magnificent form resembles in habit and general appearance, save color, *A. nutans*. The capillitium is, however, very different both in the sculpture and in the more delicate markings of the threads. Doctor Rex has pointed out the lack of reticulation on the capillitium and calyculus. The color is also diagnostic. A roseate variety seems to occur with the present form. This is *A. magna* var. *rosea* Rex, and appears to agree with the type in all respects save color. The capillitial threads are remarkable for their graceful slenderness, regularity, and symmetry.

Regarded by Lister as a form of *A. ærstedtii*, from which, however,

it is distinguished by the larger sporangia, smaller spores and the character of the capillitium as well as by the color.

Philadelphia, Long Island, Iowa, Wisconsin.

2. *ARCYRIA ÆRSTEDTHI* Rost.

Mon. 278. 1875.

Pl. XVII, Figs. 450, 451, 452.

1888. *Hemiarcyria fuliginea* Cooke & Mass., Grev. 16 : 74.

1892. *Arcyria fuliginea* (Cooke & Mass.) Masee, Mon. 169.

Sporangia cylindric, arcuate, 1.5 mm. high when unexpanded, 4–6 mm. when expanded, closely clustered, dull crimson to almost vermilion, stipitate; peridium evanescent except here and there a persistent patch; calyculus shallow, plicate, papillose within; stipe short, weak, concolorous; hypothallus distinct, membranous, concolorous; capillitium a loose, far expanding, elastic net, very easily detached, the meshes uneven, often small, the threads characterized by much irregularity and many bulbous thickenings, especially at the nodes, strongly spinulose throughout; spore-mass crimson or reddish brown, dull; spores by transmitted light colorless, minutely spinulose, subglobose, 8–10  $\mu$ . Plasmodium at first colorless, then white, finally becoming red when the sporangia begin to form.

Rostafinski's fig. 196 is excellent and gives the idea of what we regard the typical marking of the capillitium. Externally the species resembles somewhat *A. nodulosa*, and the network of the capillitium is also suggestive of that form; the spiny capillitium is unique.

Rare in the United States: New York, Pennsylvania, Washington, Oregon. Widely distributed, reported from all the continents except South America.

3. *ARCYRIA NUTANS* (Bull.) Grev.

Fl. Edin. 455. 1824.

Pl. XVII, Figs. 453, 454, 455.

1791. *Trichia nutans* Bull., Champ. 122.

1791. *Stemonitis nutans* (Bull.) Gmel., Syst. Nat. 2 : 1467.

1794. *Arcyria flava* Pers., Roemer N. Mag. Bot. 1 : 90.

1797. *Stemonitis amœna* Trent. in Roth, Cat. Bot. 1 : 222.

1803. *Trichia elongata* Schum., Enum. Pl. Sæll. 2 : 209.

1803. *Arcyria alutacea* Schum., Enum. Pl. Sæll. 2 : 212.

Sporangia crowded, cylindric, about 2 mm. high when unexpanded, 4–6 mm. when expanded, pale yellow or buff, short-stipitate or sessile by an acute base; peridium wholly evanescent, except at the base, where persists the shallow, colorless, often inwardly spinulose, plicatu-

late calyculus; stipe very short or wanting; hypothallus thin but usually in evidence; capillitium expanding to great length, forming an extremely flexible, plumose, pendulose open network of pale ochraceous tint, the threads 3–4  $\mu$  in thickness, adorned with spinules, sharp-edged transverse plates and sometimes rings, the surface marked by an indistinct reticulation; spore-mass buff or ochraceous; spores by transmitted light colorless, smooth or nearly so, 7–8  $\mu$ .

Common, especially on fallen willows. The expanded capillitia are very soft and plume-like, waving and nodding, very lightly attached below to the center of the peridial cup. The capillitial threads are rough, with irregular spines and sharp-edged transverse plates, occasionally extended to form rings. It resembles *A. magna* somewhat in habit, size and spinescent capillitium, but the resemblance is superficial only. The color is at once diagnostic, and the capillitium is after all entirely different.

Nova Scotia to Washington, south to Mexico and the Virgin Islands; cosmopolitan.

#### 4. *ARCYRIA VIRESCENS* G. Lister

Jour. Bot. 59 : 252. 1921.

Sporangia cylindrical, stalked, clustered or crowded, often forming large colonies, yellowish green; calyculus narrowly funnel-shaped, reticulated and shiny within; stalks slender, straight or flexuose, dark olive-green, 0.5–1.5 mm. long, free or adherent in clusters; capillitium a loose elastic network of greenish or yellowish threads, free from the cup and about 6 mm. long when expanded, the threads 4–6  $\mu$  wide, marked with scattered groups of close-set, prominent transverse ridges, 3–5  $\mu$  high, the remaining surface irregularly reticulate and shiny; spores yellowish green in mass, with a few scattered warts, 7–8  $\mu$ . Plasmodium white.

Resembling *A. nutans*, but differing in the greenish color, the narrow calyculus and the capillitial markings.

Rare. Iowa, Oregon; Ceylon, Malay Peninsula, Queensland, Madagascar.

#### 5. *ARCYRIA VERSICOLOR* Phillips

Grev. 5 : 115. 1877.

Pl. XVII, Figs. 456, 457, 458.

1877. *Arcyria vitellina* Phillips, Grev. 5 : 115.

Sporangia gregarious or more or less crowded, pyriform or clavate, olivaceous yellow, sometimes becoming reddish, stipitate; peridium

membranous, largely persistent below, where it gives rise to the deep, goblet-shaped calyculus; stipe strand-like, weak, sometimes wanting, concolorous with the peridium; hypothallus prominent or venulose; capillitium only slowly expanded, bright golden yellow or orange, changing to greenish, the threads rather broad, 4–6  $\mu$  in diameter, regular, even, elegantly branching, delicately spiny-reticulate, the net arising from the center of the stalk and hence loosely attached to the bottom of the vasiform calyculus; spore-mass yellow, spores by transmitted light pale or nearly colorless, smooth, 9–10  $\mu$ .

This beautiful species is easily known by its comparatively large size, peculiar, obovate shape, its brilliant color, and unusually persistent membranous calyculus. In dry woods and at lower altitudes the sporangia are apt to be small and deep yellow. At higher altitudes they tend to be larger and more varicolored, tinted with red, yellow, olive and green, not brilliant, but soft and rich.

While the name *vitellina* has priority of position, both Massee and Lister, in uniting the two species, preferred the second name, and it may be regarded as established.

A mountain species: South Dakota, Colorado, Washington, California; also the mountains of central and southeastern Europe.

# 6. ARCYRIA INCARNATA Pers.

Obs. Myc. 1 : 58. 1796.

Pl. XVIII, Figs. 461, 462, 463.

1791. *Stemonitis incarnata* Pers., in Gmel., Syst. Nat. 2 : 1467.

1803. *Trichia flexuosa* Schum., Enum. Pl. Sæll. 2 : 209.

1803. *Arcyria lilacina* Schum., Enum. Pl. Sæll. 2 : 212.

1876. *Arcyria adnata* (Batsch) Rost., Mon. App. 36. 1876.

1877. *Arcyria cinnamomea* Hazsl., Österr. Bot. Zeitschr. 27 : 84.

1884. *Arcyria irregularis* Racib., Rozpr. Nat. Przyr. Ak. Krak. 12 : 83.

Sporangia closely crowded, cylindric, 1–1.5 mm. high, rosy or flesh colored, stipitate or almost sessile; stipe generally short, sometimes barely a conical point beneath the calyculus; hypothallus none; peridium wholly evanescent, except the shallow, saucer-like, inwardly roughened calyculus; capillitium loose, broad, pale reddish, attached to the cup at the center only, by strands which enter the hollow stem, the threads adorned with transverse plates, cogs and ridges, arranged in an open spiral; spore-mass rosy; spores by transmitted light colorless, nearly smooth, 7–8  $\mu$ .

This common species is well marked by its color, by its short stipe and by the delicate attachment of the capillitium to the calyculus. This is so frail that the slightest breath often suffices to effect a separa-



tion and the empty calyculi are not infrequently the only evidence of the fructification. This peculiarity did not escape the attention of Persoon, and is well shown in his figure (Obs. Myc. 1, pl. 5, figs. 4, 5). Batsch simply named and described Micheli's figure, and accordingly his claim to priority is no better than Micheli's figure, which may possibly concern the present species, but is in no sense determinative. It is impossible to say what Retzius meant by his *Clathrus ramosus*, cited by Fries as a synonym here. The capillitium is coarser and rougher than in *A. denudata* and does not decolorize so readily in potassium hydroxide solution.

Var. *fulgens* Lister, Mycetozoa ed. 2. 242, 1911, is said to be distinguished by crimson sporangia and firm dark stalks. As both color and stipe are variable this variety seems to be of slight value.

Var. *laxa* Brandza, Bull. Soc. Myc. Fr. 44 : 283, 1929, with large sporangia, 2-3 mm. tall, becoming 3-4 mm. when the lax capillitium is fully expanded, is recorded from Rumania and Switzerland.

Common in the eastern and central portions of the United States and Canada and generally distributed in temperate regions, also the Virgin Islands; Java, Malay Peninsula, South and East Africa.

#### 7. ARCYRIA NODULOSA Macbr.

N. A. Slime-Moulds ed. 2. 252. 1922.

1899. *Arcyria incarnata* Pers. var. *nodulosa* Macbr., N. A. Slime-Moulds 194.

Sporangia small, about 1 mm. high when unexpanded, crowded in clusters of varying size, dull red or brownish, stipitate; peridium evanescent except the cup; stipe very short, concolorous, plicate as the cup, or both smooth and unmarked; capillitium centrally attached, slowly expanded, open-meshed, dense, the threads even, 5-6  $\mu$  wide, expanded in globose, spinulose, or papillate-reticulate nodules, especially at points of intersection, marked everywhere by close-set, transverse, sharp-edged ridges, which encircle the thread and show no trace of spiral arrangement; spore-mass brown or red-brown; spores by transmitted light pale yellow or colorless, minutely but distinctly roughened, globose, 10-12  $\mu$ .

This species is not distantly related to *A. incarnata*, as shown by the centrally attached capillitial mass, but differs in several definite particulars; the sporangia are much smaller, of an entirely different color, with longer stipes and larger, rougher spores; the capillitium is also peculiar, the threads unusually wide and densely corrugated transversely, expanding at frequent intervals into globose nodules which are sometimes double the width of the thread.

Pennsylvania.

8. *ARCYRIA FERRUGINEA* Sauter

Flora 24 : 316. 1841.  
Pl. XVIII, Figs. 464, 465.

- 1875. *Arcyria dictyonema* Rost., Mon. 279.
- 1876. *Arcyria intricata* Rost., Mon. App. 37.
- 1883. *Arcyria macrospora* Peck, Rept. N. Y. State Mus. 34 : 43.
- 1884. *Arcyrella inermis* Racib., Rozpr. Mat. Przyr. Ak. Krak. 12 : 82.
- 1888. *Arcyria aurantiaca* Raunk., Bot. Tidssk. 17 : 61, pl. 3, figs. 4, 9-11.
- 1893. *Arcyria clavata* Cel. fil., Myx. Böhm. 29.
- 1906. *Hemiarcyria expansa* Sacc., Syll. Fung. 18 : 212.
- 1923. *Arcyria ornata* Widder, Verh. Zool.-Bot. Ges. Wien 73 : 160.

Sporangia ovoid or short-cylindric, crowded or gregarious, dull brick-red or brownish to orange, stipitate; stipe about equal to the sporangium, dark brown or black; hypothallus well developed, membranous, yellowish brown, continuous; calyculus large, wide and shallow, smooth; capillitium centrally attached, when fresh brick-red in color, fading on exposure, the threads of uneven size, those above, 6-7  $\mu$ , below, 3  $\mu$ , abundantly branching, marked by conspicuous reticulations formed by the intersection of numerous vertical plates or ridges; spore-mass reddish; spores by transmitted light pale ochraceous, distinctly warted, 10-12  $\mu$ .

This species is distinguishable at sight by the peculiar color and form of the sporangia. Durand, in Bot. Gaz. 19 : 89-91, gives a careful study of the form. The same author declares the dehiscence circumscissile. The orange phase is said by Brandza to be abundant in Moldavia.

Rare. Nova Scotia, Maine, Massachusetts, New York, Washington, California; Europe, South Africa, Ceylon.

9. *ARCYRIA POMIFORMIS* (Leers) Rost.

Mon. 271. 1875.  
Pl. XVIII, Figs. 468, 469, 470.

- 1775. *Mucor pomiformis* Leers, Fl. Herborn. 218.
- 1788. *Stemonitis pomiformis* (Leers) Roth, Fl. Germ. 548.
- 1797. *Stemonitis ochroleuca* Trentep., in Roth, Cat. Bot. 1 : 221.
- 1797. *Stemonitis lutea* Trentep., in Roth, Cat. Bot. 1 : 221.
- 1813. *Arcyria silacea* Ditm., in Sturm, Deutsch. Fl. Pilze 1 : 15, pl. 8.
- 1822. *Arcyria lutea* (Trentep.) Schw., Schrift. Naturforsch. Ges. Leipzig 1 : 37.
- 1829. *Arcyria ochroleuca* (Trentep.) Fr., Syst. Myc. 3 : 181.
- 1885. *Arcyria winteri* Wettst., Österr. Bot. Zeitschr. 35 : 199.
- 1894. *Arcyria albida* Pers. var. *pomiformis* (Leers) List., Mycetozoa 186.

Sporangia scattered, gregarious, globose, bright yellow, very minute, 0.5 mm. high, 0.3 mm. or less in diameter, stipitate; stipe short, one-

third to one-half the total height, pale brown or yellow; hypothallus none; capillitium loose, freely expanding, not deciduous, honey yellow, the threads generally wide, 4–5  $\mu$ , toward the periphery more narrow, 2.5  $\mu$ , warted, marked with blunt spinules, which not infrequently pass into distinct transverse, narrow plates or half-rings, free ends clavate and numerous; spore-mass yellow; spores by transmitted light smooth, granular, globose, 7–9  $\mu$ .

This species as represented by the material before us seems constant in size, color and microscopic characters, in all of which it differs from other species here listed. It resembles somewhat *Lachnobolus globosus*, but differs in habit, habitat, color, attachment of capillitium and mode of dehiscence. In the present species the wall is almost completely evanescent; in *L. globosus* it is remarkably persistent, and the capillitium is adherent.

Not rare, but rather infrequently collected. Its smallness removes it from sight of all but the most exact collectors. Maine to Florida, Missouri, Ontario, California; Europe, South Africa, Japan.

While usually remotely gregarious, a collection from southern California shows that on occasion the entire plasmodium may pass to fruit with narrowest limits, forming a stipitate, compact, globose mass of crowded, superimposed sporangia as in *Oligonema nitens*.

#### 10. ARCYRIA ANNULIFERA *Torrend*

Fl. Myx. 102. 1909.

Sporangia subglobose, stalked, 0.5–0.6 mm. in diameter, scattered, buff yellow; calyculus membranous, concolorous, papillose, rather deep with an irregular margin, plicate below; stalk concolorous, 0.2–0.4 mm. high, filled with spore-like cells; capillitium scarcely elastic, of very slender threads, 1–1.5  $\mu$  in diameter, bearing prominent annular thickenings at intervals of 1–2  $\mu$ , the basal threads somewhat thicker with moniliform swellings; spores pale yellow, with a few scattered warts, 6–7  $\mu$ .

Outwardly resembling a large *A. pomiformis*, but with a wholly different capillitium.

Rare. Known only from a single collection in Portugal.

#### 11. ARCYRIA GLAUCA *Lister*

in Minakata, Bot. Mag. Tok. 22 : 322. 1908.

Sporangia ovoid or cylindrical, stalked, 0.4–2.5 mm. tall and 0.4–0.8 mm. broad when expanded, pale bluish green; calyculus funnel-shaped, membranous, somewhat plaited, faintly reticulate; stalk pale

green or grayish brown, curved, weak, 0.2–0.3 mm. high, filled with spore-like cells; capillitium elastic, threads pale, 2.5–3  $\mu$  in diameter, with many attachments to the cup and a few rounded free ends, marked with a loose spiral of prominent cogs and sometimes scattered spinules and irregular reticulations; spores pale glaucous, nearly smooth, 7  $\mu$ .

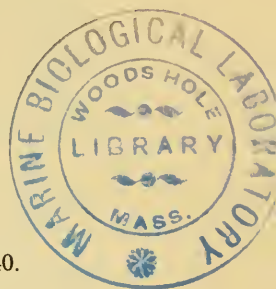
Japan, rare.

12. *ARCYRIA CINEREA* (Bull.) Pers.

Syn. Meth. Fung. 184. 1801.

Pl. XVII, Figs. 459, 460.

- 1791. *Trichia cinerea* Bull., Champ. 120.
- 1791. *Stemonitis cinerea* (Bull.) Gmel., Syst. Nat. 2 : 1467.
- 1794. *Arcyria albida* Pers., Roemer N. Mag. Bot. 1 : 90.
- 1797. *Stemonitis glauca* Trentep., in Roth, Cat. Bot. 1 : 221.
- 1838. *Arcyria trichioides* Corda, Icones 2 : 23; pl. 12, fig. 86.
- 1876. *Arcyria friesii* Berk. & Br., Ann. Mag. Nat. Hist. IV. 17 : 140.
- 1877. *Comatricha alba* Schulz., Just Bot. Jahresb. 155.
- 1892. *Arcyria cookei* Masee, Mon. 154.
- 1896. *Arcyria tenuis* Schroet., Hedwigia 35 : 207.



Sporangia scattered or gregarious, ovoid or cylindrical, generally tapering upward, rarely almost globose, about 2–3 mm. high, typically ash gray, but sometimes with a yellowish tinge, rarely rose or green, stipitate; calyculus very small, thin; stipe slender, about half the total height, rising from a small hypothallus, gray or blackish, densely crowded with spore-like cells; capillitium dense, freely branching, ashen or yellowish, 3–4  $\mu$ , wider below, minutely spinulose; spore-mass concolorous; spores by transmitted light colorless, smooth, 6–7  $\mu$ . Plasmodium gray, white or yellowish.

A very common little species, easily recognized in its typical expression by its color and habit. The capillitium is more dense than in any other species and expands somewhat less vigorously than in most. The stipe is about equal to the expanded capillitium, unusually long. The plasmodium occurs in rotten wood, especially species of *Tilia*, and judging from the number of sporangia found in one place, is usually scanty. Bulliard gives the first account of the species by which it can with any certainty be identified.

Maine to Alaska, and south to Mexico, Nicaragua, West Indies, South America. World-wide in its distribution.

*Arcyria nigella* Emoto (Bot. Mag. 42 : 201, 1928), described from Japan, is a minute form sometimes showing bluish tints, with a weak capillitium, spores given as 7–9  $\mu$  and a strongly netted calyculus. The photographic illustration of the spores, at a magnification given



as  $\times 1000$ , shows most of them to range from  $6-8\ \mu$  with only one spore attaining  $9\ \mu$ .

### 13. *ARCYRIA DIGITATA* (Schw.) Rost.

Mon. 274. 1875.  
Pl. XVIII, Figs. 471, 472.

- 1832. *Stemonitis digitata* Schw., Trans. Am. Phil. Soc. II. 4 : 260.
- 1855. *Stemonitis grisea* Opiz, Lotos 215.
- 1855. *Arcyria lepreuri* Mont., Ann. Sc. Nat. Bot. IV. 3 : 141.
- 1869. *Arcyria bicolor* Berk. & Curt., Jour. Linn. Soc. 10 : 349.
- 1873. *Arcyria pallida* Berk. & Curt., Grev. 2 : 67.
- 1876. *Arcyria stricta* Rost., Mon. App. 36.
- 1925. *Arcyria cinerea* (Bull.) Pers. var. *digitata* (Schw.) G. List., Mycetozoa ed. 3. 232.

Sporangia gathered in tufts, 3-12 or more on a single stipe, the clusters themselves scattered; individual sporangia elongate-cylindric, 2-4 mm. long, or rarely globose, ashen gray or nearly white, stipitate; stipe as long as the sporangium, or longer, stout, sometimes showing traces of consolidation of several, dark brown or black; capillitium looser and more expanded than in *A. cinerea*, the threads more strongly spinulose; spore-mass concolorous; spores under the lens globose, colorless, with irregularly scattered warts,  $7.5-8\ \mu$ .

Closely related to the preceding species of which it is commonly regarded as a variety, but different in habit and on the whole larger and more robust throughout. The stipes in some cases are completely merged in one; in others traces of coalescence remain. The number of united sporangia varies. There are some clusters before us containing 16 and 18 in a single fascicle!

New England, Pennsylvania, Ohio, South Dakota, Washington, south to Brazil; Europe, the tropics generally. Not common in temperate regions but abundant in the tropics.

### 14. *ARCYRIA CARNEA* G. Lister

Jour. Bot. 59 : 92. 1921.

- 1911. *Arcyria cinerea* (Bull.) Pers. var. *carnea* Lister, Mycetozoa ed. 2. 236.

Sporangia stalked, loosely clustered, flesh colored, ovoid or short-cylindrical, 1.5 mm. tall; calyculus marked with papillæ or with a broken reticulation, giving attachment to the capillitium; stalks short, 0.2-0.4 mm.; capillitium a compact network of pale flesh colored threads about  $3.5\ \mu$  wide, marked with close-set prominences arranged in a loose spiral and appearing truncate, notched or hammer-shaped

in profile, the remainder either smooth or with a broken reticulation or faint spirals; spores nearly smooth, 6–8  $\mu$ .

Occasional collections regarded as pinkish forms of *A. cinerea* agree very closely with this description. The name *A. carnea* Schum., Enum. Pl. Sæll. 2 : 213, 1803, was used, as noted by Miss Lister, for a form which cannot now be determined. The name adopted by Miss Lister is therefore a homonym, and invalid, but pending further study to determine whether the form is entitled to specific recognition, it may be used.

Long Island(?); Europe, Manchuria, Japan.

15. *ARCYRIA INSIGNIS* Kalch. & Cooke

Grev. 10 : 143. 1882.

Sporangia gregarious or clustered, pale or bright rose, 0.5–1.5 mm. in height, stipitate, ovate or cylindric; stipe short, 0.2–0.4 mm., red, with spore-like cells; capillitium a close network of delicate threads with a few bulbous free ends, with faint transverse bands or short spinules, or sometimes nearly smooth, colorless beneath the lens; spores colorless, nearly smooth, 6–8  $\mu$ .

Superficially resembling small forms of *A. denudata*, from which it is distinguished by its shorter stipe and more delicate capillitium with less conspicuous markings. The color, too, is different; our specimens are more or less salmon colored—grenadine pink to carrot red of Ridgway.

The var. *major* G. List., Mycetozoa ed. 3. 236, described as larger, and deeper rose, suggests certain phases of *A. denudata*. Brandza, who finds it abundant in Moldavia, agrees with Miss Lister in placing it here.

The var. *dispersa* Hagelstein, Mycologia 21 : 298, 1929, is scattered instead of clustered, growing on decaying beach grass.

Rare in North America: Massachusetts, Long Island, Washington, South America; Europe, Ceylon, Malay Peninsula, Japan, South and West Africa, Australia.

16. *ARCYRIA DENUDATA* (L.) Wettstein

Verh. Zool.-Bot. Ges. Wien 36 : 585. 1886.  
Pl. XVIII, Figs. 473, 474, 475.

1753. *Clathrus denudatus* L., Spec. Pl. 1179.

1772. *Mucor clathroides* Scop., Flor. Carn. ed. 2. 2 : 493.

1775. *Mucor pyriformis* Leers, Fl. Herborn. 288.

1786. *Embolus crocatus* Batsch, Elench. Fung. Cont. 1: 265.

1788. *Stemonitis coccinea* Roth, Fl. Germ. 548.

1789. *Trichia denudata* (L.) Vill., Pl. Dauph. 1060.  
 1790. *Trichia graniformis* Hoffm., Veg. Crypt. 1 : 3.  
 1791. *Trichia cinnabaris* Bull., Champ. 121.  
 1791. *Stemonitis crocea* Gmel., Syst. Nat. 2 : 1467.  
 1792. *Trichia rufa* Wither., Br. Pl. ed. 2. 3 : 478.  
 1794. *Arcyria punicea* Pers., Roem. N. Mag. Bot. 1 : 90.  
 1803. *Arcyria conjugata* Schum., Enum. Pl. Sæll. 2 : 215.  
 1876. *Arcyria vernicosa* Rost., Mon. App. 36.

Sporangia crowded or gregarious, stalked, ovoid or short-cylindric, tapering upward, 2-3 mm. tall, pompeian red \* to brick-red \* weathering to various shades of reddish brown and brown; peridium evanescent except for the plicate calyculus; stipe about equal to the expanded capillitium, concolorous, plicate or striate, ascending from a small hypothallus; capillitium attached to the whole inner surface of the calyculus and connate with it, hence not deciduous, bright red or carmine when fresh, turning brown or paler with age, the threads marked with a series of rather distant cogs or half-rings, which form around them a lengthened spiral, the axis 3-4  $\mu$  in diameter; spore-mass red or reddish brown; spores by transmitted light colorless, nearly smooth, 6-8  $\mu$ .

This species is easily distinguished from others of similar tints, except *A. insignis*, by the attachment of the capillitium. In this respect it corresponds with *A. cinerea*. In the adornment of the threads it is like *A. incarnata*. It is by far the commonest species of the genus, and probably enjoys a world-wide distribution. To be found at all seasons on the lower side of fallen sticks.

Micheli, pl. 94, shows that he had the present species. The description given by Linnæus is worthless, but helped out by Micheli. Several other authors of the eighteenth century, who take the trouble to describe the species, give the Linnæan binomial as a synonym. As a matter of fact, Batsch first presents an unmistakable description and figure under the name *Embolus crocatus*.

Most likely to be confused with *A. incarnata*, from which it may be distinguished by the attachment of the capillitium, the longer stipe and the markings and size of the capillitial threads.

Common throughout North and South America and Europe and probably the world.

### 3. *Heterotrichia* Masee

Mon. 139. 1892.

Sporangia distinct, stipitate; peridium simple, evanescent above as in *Arcyria*; capillitium centrally attached, freely branched, the threads within very slender, without broad, anastomosing to form a dense

peripheral network, and everywhere extended to form short, free, often hamate tips.

A single species:

*HETEROTRICHIA GABRIELLÆ* Masee

Mon. 140. 1892.

1909. *Arcyria ferruginea* Sauter var. *heterotrichia* Torr., Fl. Myx. 98.

1910. *Arcyria ferruginea* Sauter var. *gabriellæ* (Mass.) Grove, Birm. Nat. Hist. Phil. Soc. 12 : 20.

Sporangia crowded or gregarious, ovate or oblong, cylindric, stipitate, at first red, becoming yellowish brown; peridium evanescent except the calyculus, which is small, thin, polished; stipe much shorter than the expanded capillitium, pale reddish brown; capillitium centrally attached, showing threads of two sorts, those within freely branching, slender, 1–1.5  $\mu$ , marked with half-rings or ridges, those on the periphery very different, yellow, broad, 5–6  $\mu$ , forming rather dense reticulations, with abundant free tips, acute and often curved, the whole surface here minutely and densely spiny-reticulated; spore-mass reddish yellow; spores by transmitted light colorless, globose, 7–8  $\mu$ .

The peculiar double capillitium seems to separate this form from the true *arcyrias*. Some difference in the diameter of the capillitial threads in different regions is not infrequent in the several species of *Arcyria*, but that difference is here emphasized and rendered yet more striking by the peculiar free tips. The present form bears only the most superficial resemblance to *A. ferruginea* Saut., of which species it is commonly regarded as a variety.

The name *Arcyria gabriellæ* Rav., cited by Masee, under which Ravenel sent it to Cooke, was never validly published.

Very rare. Collected in South Carolina in 1850 and many years later, 1896, by Harvey in Maine.

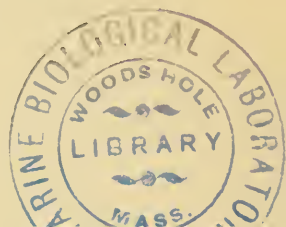
4. *Cornuvia* Rost.

Versuch 15. 1873.

Sporangia sessile or plasmodiocarpous; capillitium a network, the threads marked by complete rings; spores reticulate.

The capillitium is netted as in *Arcyria* and *Hemitrichia*, but the prominent ring-like markings are distinctive, although the rare *Arcyria annulifera* is described as bearing on its capillitial threads complete rings, apparently of a different character.

A single species:





CORNUVIA SERPULA (*Wigand*) *Rost.*

Versuch 15. 1873.

1863. *Arcyria serpula* Wigand, Prings. Jahrb. Bot. 3 : 44.1892. *Ophiotheca serpula* (Wig.) Massee, Mon. 135.

Sporangia sessile, subglobose and about 0.3 mm. in diameter or forming small plasmodiocarps, shining golden yellow; peridium membranous, smooth, pale yellow; capillitium netted, flaccid, the freely branching threads 3–5  $\mu$  in diameter, marked with prominent rings which are often more or less clustered; spores yellow, reticulate, with 8–12 meshes to the hemisphere, 10–12  $\mu$ .

Not common. Europe, East Africa, North India. Not known from the western hemisphere.

## FAMILY TRICHIACEÆ

Capillitium thread-like, sculptured with spiral bands, sometimes with rings and knobs; threads free, fascicled or forming a network.

## KEY TO THE GENERA OF THE TRICHIACEÆ

- a.* Capillitial threads solid, marked with spirals, fascicled, arising from base and branching in upper part, the tips attached to the sporangium wall. . . . . 1. *Prototrichia*
- a.* Capillitial threads free or united into a net, not fascicled nor attached. . . . . *b*
  - b.* Capillitial threads short, entirely free, sometimes branched. . . . . *c*
  - b.* Capillitial threads long, united into a net. . . . . *d*
- c.* Spirals irregular, faint, sometimes wanting. . . . . 2. *Oligonema*
- c.* Spirals distinct, usually regular. . . . . 3. *Trichia*
- d.* Spirals regular. . . . . 4. *Hemitrichia*
- d.* Spirals fragmentary, more or less obscured by a reticulation 5. *Calonema*

1. *Prototrichia* *Rost.*

Mon. App. 38. 1876.

Fructification sporangiate or somewhat plasmodiocarpous, rarely short-stipitate; peridium thin, transparent; capillitium of solid, spirally banded threads, attached at base of sporangium and becoming subdivided, the penicillate tips attached to the upper sporangium wall; spores brown in mass, pallid, pinkish by transmitted light.

A single species:

PROTOTRICHIA METALLICA (*Berk.*) *Massee*

Jour. Roy. Micr. Soc. 1889 : 350.

Pl. XVIII, Figs. 478, 479, 480.

1859. *Trichia metallica* Berk., in Hooker, Fl. Tasm. 268.1866. *Trichia flagellifer* Berk. & Br., Ann. Mag. Nat. Hist. III. 18 : 56.

1876. *Prototrichia flagellifer* (Berk. & Br.) Rost., Mon. App. 38.  
1876. *Prototrichia elegantula* Rost., Mon. App. 39.  
1889. *Prototrichia cuprea* Mass., Jour. Roy. Micr. Soc. 351.  
1892. *Prototrichia chamaleontina* Mass., Mon. 130, in part.  
1921. *Prototrichia schroeteri* Meylan, Bull. Soc. Vaud. Sc. Nat. 53 : 462.

Sporangia sessile, scattered or sometimes crowded, orange-brown to dull brown, sometimes with a rosy tinge, 0.5–1 mm. in diameter or larger; peridium a thin, transparent, iridescent membrane, bearing on its inner surface the distal attachments of the capillitial threads; capillitium of numerous brown, spirally banded threads, which take origin in the base of the sporangium, become subdivided as they ascend, the branches often interwoven spirally, and are at length attached by their tips to the sporangium wall; spore-mass brown; spores by transmitted light pale, spiny, 10–13  $\mu$ , occasionally up to 15  $\mu$ .

This curious form, with its spirally sculptured capillitial threads attached at both ends, stands intermediate between *Dianema* on the one hand and *Hemitrichia* and *Trichia* on the other. Berkeley called it a *trichia*, ignoring the attachment of the threads. Cooke notes this as sufficient to exclude the form from the genus. It remained for Rostafinski to make the transfer by setting up for its reception the genus now adopted. He preferred the later (1866) specific name as more descriptive. Miss Lister reverts to the earlier name with the remark: "Little now remains of the type of *Trichia metallica* Berk. from Tasmania; but the specimen is referred to *Prototrichia flagellifera* by Rostafinski, who saw it in good condition."

Not uncommon in the coniferous forests of the west. Alberta to Washington, California and Colorado; also Tasmania, Europe.

## 2. *Oligonema* Rost.

Mon. 291. 1875.

Fructification sporangiate, or rarely somewhat plasmodiocarpous, gregarious to densely crowded, often superimposed; peridium transparent, yellow to olivaceous; capillitium usually rather scanty, of short elaters, faintly sculptured with spirals and often bearing rings, cogs or warts, the apices blunt or with a minute apiculus; spores light yellow or pallid, warted or reticulate.

Since the direction of the spirals seems to be constant in the two common species, and since the terms *dextrorse* and *sinistrorse* have not always been used consistently, it will be well to explain that *dextrorse* means winding clockwise toward the point of the elater and *sinistrorse* the reverse. The threads of an ordinary screw are *sinistrorse*. This is the sense preferred in Jackson's "Glossary of Botanic Terms."

This genus has been carefully studied by Miss Baskerville (1932) and the following treatment is based in part upon her findings.

#### KEY TO THE SPECIES OF OLIGONEMA

- a. Spores warted. . . . . 1. *O. fulvum*
- a. Spores reticulate. . . . . b
- b. Elaters usually rough, spirals sinistorse, indistinct. . . . . 2. *O. flavidum*
- b. Elaters nearly smooth, with faint dextrorse spirals and scattered rings. . . . . 3. *O. nitens*

#### 1. OLIGONEMA FULVUM *Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 36. 1893.  
Pl. XVIII, Figs. 486, 487.

Sporangia olivaceous brown, sessile, clustered, subglobose, tending toward plasmodiocarpous, up to 1 mm. in diameter; peridium light olivaceous yellow, fugacious, marked with clear, straight lines arranged at various angles and suggesting clusters of needle-shaped crystals, and with warts; capillitium tawny yellow, scanty, the elaters simple or branched, smooth or with faint spirals or occasional rings, half-rings or barbs, occasionally swollen, 40–300  $\mu$  in length, 3–5  $\mu$  wide; spores globose, light yellow, distinctly warted, 12–14  $\mu$ .

According to Lister, this species is to be included in *Trichia scabra*. The complete lack of reticulation on the spore walls, together with the other characters, seems to rule this out.

Rare, known only from Ohio.

#### 2. OLIGONEMA FLAVIDUM *Peck*

Rept. N. Y. State Mus. 31 : 43. 1879.  
Pl. XVIII, Figs. 482, 483, 484, 485, 488.

1874. *Perichæna flavida* Peck, Rept. N. Y. Mus. 26 : 76.

1889. *Oligonema minutulum* Massee, Jour. Roy. Micr. Soc. 348.

Sporangia yellow, sessile, densely clustered, globose, subglobose, or elongated by pressure, 0.5–0.8 mm. in diameter; peridium thin, opaque, papillate, opening irregularly; capillitium scanty, of rather short, simple or occasionally branched elaters, 100–300  $\mu$  long and 3–4  $\mu$  wide, irregular, swollen in places and with scattered depressions on the surface, sculptured with minute warts arranged so as to form indistinct, sinistorse spirals, the apices generally blunt, sometimes ending in one to several points; spores globose, irregularly reticulate, 11–14  $\mu$ .

Distinguished from *O. nitens* chiefly by the uneven, roughened surface of the elaters and the direction of the spirals. The reticulations on the spore walls are usually more regular and the pitting, if present,

less conspicuous. The colonies are usually larger, as are the individual sporangia.

*Oligonema brevifilum* Pk., Rept. N. Y. Mus. 31 : 42, 1879, was established upon a form with extremely short elaters. In the first edition of the Lister monograph this was included in *O. nitens*. Doctor Sturgis, after reëxamination of Peck's type, decided that it was a variety of *O. flavidum* and so published it (Trans. Conn. Ac. 10 : 488, 1900). In the second and third editions of Lister it was included in that species. Miss Baskerville, after examining the available material in the Iowa collections, decided that it should be a variety of *nitens* (Trans. Ia. Ac. 38 : 107, 1932). Further examination shows that forms with short elaters may be found in both species, and that they grade imperceptibly into the forms with longer elaters, regarded as typical. The species and the two proposed varieties are therefore regarded as unnecessary.

Both this and the following species develop on wood and litter in moist places, and not rarely directly on moist earth under fallen logs.

Fairly common. New England to British Columbia and North Carolina, Alabama, California; Europe, North Africa.

### 3. OLIGONEMA NITENS (Lib.) Rost.

Mon. 291. 1875.

Pl. XVIII, Figs. 481, 489.

1834. *Trichia nitens* Lib., Pl. Crypt. Add. Fasc. 3, No. 277, *non* Pers.

1873. *Physarum schweinitzii* Berk., Grev. 2 : 66.

1873. *Cornuvia nitens* (Lib.) Rost., Versuch 15.

1876. *Trichia kickxii* Rost., Mon. App. 40.

1879. *Trichia bavarica* de Thüm., Myc. Univ. No. 1497.

1885. *Trichia pusilla* Schroet., Krypt. Fl. Schles. 3 (1) : 114, *non* Poir.

1888. *Oligonema bavaricum* (de Thüm.) Balf. & Berl. in Sacc. Syll. 7 : 437.

Sporangia bright yellow, shining, sessile, irregularly spherical, up to 0.5 mm. in diameter, usually crowded into dense clusters and often superimposed; peridium thin, marked with fan-like tracery, sometimes with warts; capillitium of short elaters, mostly 100–150  $\mu$  long and 3–4  $\mu$  wide, simple or branched, smooth or marked with occasional rings or faint dextrorse spirals; apices either blunt or with an apiculus, the latter 4–6  $\mu$  long and usually bent; spores irregularly reticulate, the bands pitted, 12–14  $\mu$ .

The small, glistening, heaped sporangia, the smoother elaters, with sinistrorse spirals and the pitted spore bands distinguish it from *O. flavidum*. Forms with very short elaters occur, as in that species.

Canada and New England to California and south to Florida and



the Gulf, often on watersoaked wood or on moist soil. Also Europe, North Africa.

### 3. *Trichia* Haller emend. Rost.

Mon. 243. 1875.

1768. *Trichia* Haller, Hist. Stirp. Helv. 3 : 114, in part.

Sporangia distinct, sessile or stipitate; capillitium of distinct elastic threads, free, acuminate at each end, yellow or more rarely reddish or brown; spores generally yellow.

The trichias are easily recognized among their kind by their beautiful, spirally wound, elastic capillitial threads, the elaters; these are entirely free, simple or only rarely branched, and generally acute at each extremity. The spiral bands, sometimes called *tæniæ*, are generally very uniform in thickness, distance from each other, and pitch, and in many species are further reënforced by minute longitudinal plications running from one spiral to the next. Furthermore, the spirals may be smooth or spinulose, the elaters uniform throughout or enlarged by nodes and swellings. Taken altogether, the trichias, with the species of the genus next following, exhibit the highest degree of differentiation attained by the Myxomycetes.

It is not unusual to find trichias with a more or less net-like capillitium and hemitrichias with the net broken into more or less elater-like portions, suggesting the very close relationship of the two genera. *Hemitrichia helvetica* Meylan is an example. Miss Lister regards this species as an aberrant development of *Trichia affinis*.

Most of the earlier authors, including Haller, used the generic name *Trichia* to cover a variety of forms. It is here used with the limits sketched by de Bary in 1859 and 1864, and followed more exactly ten years later by his pupil, Rostafinski.

#### KEY TO THE SPECIES OF TRICHIA

- |   |                           |
|---|---------------------------|
| a. Sporangia sessile. . . . .   | b                         |
| a. Sporangia stalked. . . . .   | m                         |
| b. Pulvinate or somewhat plasmodiocarpous; usually gregarious, sometimes crowded. . . . . | c                         |
| b. Sporangiate; usually crowded, sometimes merely gregarious. . . . .                     | h                         |
| c. Black or dark purple; spores over 13 $\mu$ . . . . .                                   | d                         |
| c. Lighter; spores under 13 $\mu$ . . . . .   | e                         |
| d. Wall single; elaters 7-8 $\mu$ thick, warted. . . . .                                  | 5. <i>T. cascadiensis</i> |
| d. Wall double; elaters 4-6 $\mu$ , smooth or spiny. . . . .                              | 4. <i>T. alpina</i>       |
| e. Dark ochraceous to purplish brown. . . . .   | 6. <i>T. macbridei</i>    |
| e. Yellow or olivaceous; peridium membranous, little encrusted                            | 7. <i>T. lutescens</i>    |
| e. Reddish or purplish brown. . . . .   | f                         |
| f. Capillitium with prominent spines. . . . .   | 3. <i>T. iowensis</i>     |
| f. Capillitium spineless. . . . .   | g                         |

- |  |                           |
|--|---------------------------|
| g. Spirals even, regular . . . . .                                     | 2. <i>T. inconspicua</i>  |
| g. Spirals irregular . . . . .   | 1. <i>T. contorta</i>     |
| h. Elaters with two spirals . . . . .                                  | 8. <i>T. varia</i>        |
| h. Elaters with three or more spirals . . . . .                        | i                         |
| i. Spores finely reticulate . . . . .                                  | 9. <i>T. scabra</i>       |
| i. Spores coarsely, often imperfectly reticulate . . . . .             | j                         |
| j. Spore bands narrow, not pitted . . . . .                            | 10. <i>T. favoginea</i>   |
| j. Spore bands pitted . . . . .  | k                         |
| k. Spore bands narrow; elaters with long, slender tips . . . . .       | 11. <i>T. pulchella</i>   |
| k. Spore bands broad; tips of elaters short . . . . .                  | l                         |
| l. Spores 13–15 $\mu$ , reticulation complete . . . . .                | 12. <i>T. affinis</i>     |
| l. Spores 10–13 $\mu$ , reticulation broken . . . . .                  | 13. <i>T. persimilis</i>  |
| m. Spores reticulate . . . . .   | n                         |
| m. Spores minutely warted . . . . .                                    | o                         |
| n. Reticulations prominent, coarse . . . . .                           | 14. <i>T. verrucosa</i>   |
| n. Reticulations delicate . . . . .                                    | 17. <i>T. decipiens</i>   |
| o. Elaters spiny . . . . .   | 15. <i>T. erecta</i>      |
| o. Elaters without spines . . . . .                                    | p                         |
| p. Elaters of uniform thickness with short tips . . . . .              | 16. <i>T. subfusca</i>    |
| p. Elaters tapering very gradually to the long, slender tips . . . . . | q                         |
| q. Spore-mass ochraceous; stem opaque . . . . .                        | 18. <i>T. botrytis</i>    |
| q. Spore-mass brick-red; stem translucent . . . . .                    | 19. <i>T. floriformis</i> |

# 1. TRICHIA CONTORTA (*Ditmar*) *Rost.*

Mon. 259. 1875.

Pl. XVIII, Figs. 490, 491; Pl. XIX, Fig. 495.

1813. *Lycogala contortum* Ditmar, in Sturm, Deutsch. Fl. Pilze 1 : 9.  
 1829. *Perichæna contorta* (Ditm.) Fr., Syst. Myc. 3 : 192.  
 1833. *Licea contorta* (Ditm.) Wallr., Fl. Crypt. Germ. 2 : 345.  
 1874. *Trichia reniformis* Peck, Rept. N. Y. State Mus. 26 : 76.  
 1881. *Trichia heterotrichia* Balf. fil., Grev. 10 : 117.  
 1893. *Trichia pachyderma* Čel. fil., Myx. Böhm. 38.  
 1893. *Trichia intermedia* Čel. fil., Myx. Böhm. 38.  
 1903. *Oligonema fulvum* Pav. & Lag., Bull. Soc. Myc. Fr. 19 : 99, non Morgan.

Sporangia sessile, gregarious or crowded, small, ellipsoid or reniform, arcuate, dark red-brown, sessile; hypothallus none; capillitial mass ochraceous or dull yellow, the elaters few, irregular, the spirals uneven, irregular, often projecting and thin, though generally flat or obscure, the apices more or less swollen, ending in a curved tip; spore-mass concolorous; spores beneath the lens bright yellow, papillose, 10–13  $\mu$ .

This species resembles *T. inconspicua* in color, but is of less aggregate habit, and the sporangia are more plasmodiocarpous, reniform, arcuate, etc. The capillitium is also distinctive, the sculpture irregular, uneven, with general lack of symmetry. Our description is made up from specimens of *T. reniformis* Peck, which appears to be the American form of Rostafinski's species.

Rare. Maine, New Hampshire, New York, Ontario, Montana (?); Europe.

The var. *crenulata* Meylan, Bull. Soc. Vaud. Sc. Nat. 55 : 244, 1924 (= *T. crenulata* Meyl., l. c. 57 : 47, 1929) has regular, somewhat spiny and crested spores. The spiny elaters suggest *T. iowensis* which, however, together with *T. inconspicua*, Lister and Meylan regard as merely a developmental variation of *T. contorta*.

## 2. TRICHIA INCONSPICUA Rost.

Mon. 259. 1875.

Pl. XVIII, Figs. 492, 493; Pl. XIX, Fig. 494.

1889. *Trichia advenula* Masee, Jour. R. Micr. Soc. 336.

1891. *Trichia andersoni* Rex, Proc. Acad. Nat. Sc. Phila. 395.

1893. *Trichia rostafinskii* Cel. fil., Myx. Böhm. 37.

1894. *Trichia contorta* (Ditm.) Rost., var. *inconspicua* (Rost.) Lister, Mycetozoa 169.

Sporangia sessile, gregarious or crowded, small, hemispherical, ellipsoidal or arcuate, about 0.5 mm. across, yellow-brown or reddish brown; hypothallus sometimes not evident; capillitium dull, dark, ochraceous, the elaters long, slender, even, about 4  $\mu$  wide, the spirals three or four, rather closely wound, the apices attenuate, acute, sometimes turned to one side; spore-mass concolorous; spores pale ochraceous, minutely but distinctly warted, 10–12  $\mu$ .

One of the smallest of the trichias, not uncommon in the Mississippi valley on decaying fallen stems of *Populus*. Distinguished at sight from all except *T. iowensis* by its small size and brown color. Under the lens the long, delicate, finely sculptured capillitial threads, with fine tapering ends, are distinctive.

Not common, or at least not often collected, but widely distributed. Northern United States and Canada across the continent; Europe, Manchuria. Specimens from Oregon have spores 13–14  $\mu$  in diameter.

## 3. TRICHIA IOWENSIS Macbr.

Bull. Lab. Nat. Hist. Iowa 2 : 133. 1892.

Pl. XIX, Figs. 496, 497, 498.

1908. *Trichia contorta* (Ditmar) Rost. var. *iowensis* (Macbr.) Torrend, Broteria 7 : 55.

Sporangia sessile, gregarious, spherical or reniform, with no hypothallus, purple-brown; spores and spore-mass yellow; elaters with three or four spiral bands unevenly distributed, and with occasional inflations, sparingly branched, spinulose, especially where inflated,

spinules long, 3–6  $\mu$ , recurved, often bifid or trifid, especially at or near the acuminate tip; spores delicately warted, 9–11  $\mu$ .

This species occurs not rarely and is found on the bark of *Populus*, so far, exclusively. The sporangia are inconspicuous until after opening, when they display the yellow spores and capillitial threads. The species is immediately recognized by its elaters, whose numerous and lengthened spinules are unlike those of any cognate form, reminding one of the capillitium of *Ophiotheca wrightii*. Related to *T. contorta* and *T. inconspicua*, but distinct by its spinulose capillitium.

Iowa, Missouri, South Dakota.

#### 4. TRICHIA ALPINA (*R. E. Fries*) Meylan

Bull. Soc. Vaud. Sc. Nat. 53 : 460. 1921.

1906. *Trichia contorta* (Ditmar) Rost. var. *alpina* R. E. Fries, Arkiv Bot. 6, No. 7 : 5.

Sporangia sessile, pulvinate or plasmodiocarpous, scattered or clustered, 0.5–0.7 mm. broad, purple-black or black; wall cartilaginous, of two layers, the outer chestnut or olive-brown, thickened with granular deposits, the inner translucent, olive or yellow; capillitium of bright yellow elaters, 4–6  $\mu$  wide, marked with two to six spiral bands, sometimes spinulose; spores bright yellow in mass, globose or oval, minutely warted, 13–20  $\mu$ . Plasmodium orange-red.

According to Meylan (1931), the black sporangia are the result of incomplete development. When the sporangia mature normally, the color is purple, coppery or tawny and the peridium is thinner than as usually described.

Washington; Europe.

#### 5. TRICHIA CASCADENSIS *Gilbert*

Am. Jour. Bot. 19 : 145. 1932.

Sporangia scattered or loosely clustered, sessile, globose or forming short plasmodiocarps, 1 mm. in diameter and 1 to 4 mm. long, dull black, with no hypothallus; peridium single, thick, granular, dull black on both surfaces, breaking irregularly to expose the yellow spores and capillitium; elaters numerous, long, 7 to 8  $\mu$  in diameter, the spiral bands thin, uneven and closely wound, three to five, covered with many fine warts which are most numerous along the edges of the bands, the tips of the elaters rounded, without enlargements, and entirely covered with the warted spiral bands, each elater with a conspicuous granular core; spores globose, yellow in mass, almost colorless under the lens, minutely and unevenly warted, 14–16  $\mu$ .



The species is near to *T. alpina* Meyl. but differs so definitely that it seems reasonable to consider it separate. The elaters are larger than those of *T. alpina* and unlike those of any other *Trichia*. The bands, core and tip of the elaters are distinctive. The simple peridium is quite different from the distinctly double peridium of *T. alpina*.

Oregon, Washington.

6. *TRICHIA MACBRIDEI* M. Peck

Am. Jour. Bot. 19 : 145. 1932.

Sporangia closely gregarious or crowded on a strongly developed, dark hypothallus, purplish brown to dark ochraceous, sessile, depressed-globose, oval or forming short curved or annular plasmodiocarps; peridium somewhat iridescent, thin, translucent but finely granular, breaking irregularly; capillitium and spore-mass ochraceous; elaters very long to very short in the same sporangium, simple, uneven, abruptly contracted to simple or bifurcate tips, marked throughout with scattered blunt spines and warts, the spirals mostly three to four, imperfectly developed, sometimes broken and replaced for a distance with half-rings; spores finely and closely spinulose, 11–13  $\mu$ . Plasmodium bright pink.

The relationship is with *T. contorta* (Ditm.) Rost., a species already sufficiently confused. The pink plasmodium, large sporangia, strongly developed hypothallus and details of capillitial structure distinguish it.

Oregon. Decaying logs of *Populus trichocarpa*.

7. *TRICHIA LUTESCENS* Lister

Jour. Bot. 35 : 216. 1897.

1892. *Oligonema furcatum* Buckn., in Masee, Mon. 173.

1894. *Trichia contorta* (Ditmar) Rost., var. *lutescens* Lister, Mycetozoa 169.

1908. *Hemitrichia karstenii* (Rost.) List. var. *lutescens* Torr., Bull. Soc. Port. Sc. Nat. 2 : 62.

1919. *Hemitrichia obrussea* Meylan, Bull. Soc. Vaud. Sc. Nat. 52 : 449.

Sporangia sessile or rarely with short stalks, scattered or in small clusters, globose or pulvinate, 0.15–0.7 mm. in diameter, shining bright yellow or olivaceous; sporangium wall yellow, membranous, without granular deposits, often marked with the impression of the contained spores; capillitium of simple or branching elaters, of various lengths, 3–4.5  $\mu$  in diameter, marked with four or five distinct or often faint spiral bands, tapering or blunt and bulbous at the tips; spores bright yellow or olivaceous, finely warted or spinulose, 10–12  $\mu$ . Plasmodium watery pink.

Allied to *T. contorta*, from which it is distinguished by the translucent wall free from granular deposits.

Meylan distinguishes the yellow forms as var. *auronitens*. *Hemitrichia obrussea* Meylan is regarded by Miss Lister as "clearly only an abnormal form" of this species. Meylan, in his 1931 paper, thinks it is close only to the var. *auronitens* and that the latter is worthy of specific recognition. Examination of a specimen sent by Dr. Meylan shows it to be a hemitrichia, with only a few free ends, and apparently normal. A small and incompletely matured collection from Colorado seems to be the typical form and is our only American record. Colorado; Europe.

#### 8. TRICHIA VARIA Pers.

Roemer N. Mag. Bot. 1 : 90. 1794.  
Pl. XIX, Figs. 499, 500, 501.

- 1791. *Stemonitis varia* Pers., in Gmel., Syst. Nat. 2 : 1470.
- 1796. *Trichia olivacea* Pers., Obs. Myc. 1 : 62.
- 1799. *Trichia cordata* Pers., Obs. Myc. 2 : 33.
- 1799. *Trichia cylindrica* Pers., Obs. Myc. 2 : 33.
- 1799. *Trichia pyriformis* Pers., Obs. Myc. 2 : 33.
- 1801. *Trichia nigripes* Pers., Syn. Meth. Fung. 178.
- 1838. *Trichia craterioides* Corda, Icon. 2 : 21, pl. 12, fig. 85.
- 1893. *Trichia aculeata* Cél. fil., Myx. Böhm. 34.

Sporangia gregarious or sometimes closely crowded, globose, obovoid, or irregularly globoid, yellowish or ochraceous, shining, sessile, or rarely with a short black stipe; hypothallus inconspicuous; capillitium of rather long, simple or more rarely branched elaters, 4–5  $\mu$  wide, marked by two irregular spirals, prominent and narrow and in places remote, the apices acute, about twice the elater diameter; spore-mass yellow; spores by transmitted light dull yellow, delicately verruculose, guttulate, 12–14  $\mu$ . Plasmodium white.

A very common species, very variable in form, stipitate forms occurring occasionally beside those which are irregular and sessile. According to Rostafinski the stipitate phase constitutes *T. nigripes* of Persoon and other authors. The capillitium is, however, characteristic throughout. The two spiral bands wind loosely and irregularly and present an elater unlike anything else in the group except the same structure in *T. contorta*, but here the elater is narrow and the sculpture obscure. Since the specific distinctions are purely microscopic, the synonymy beyond Rostafinski is mainly conjectural. It is possible that Fries properly applied the name.

Common. Maine to Washington, Oregon and California, and

south to Arkansas and Alabama; Europe, North Africa, India, Ceylon, Manchuria.

Var. *olivacea* Brandza differs only in the olivaceous color of the sporangium and the plasmodium.

#### 9. *TRICHIA SCABRA* Rost.

Mon. 258. 1875.

Pl. XIX, Figs. 502, 503.

1889. *Trichia nitens* Fr. ex Mass., Jour. R. Micr. Soc. 333.

Sporangia sessile, closely crowded upon a well-developed hypothallus, regular, globose or turbinate-globose, 0.6–0.8 mm. in diameter, orange or golden brown, smooth, shining; capillitial mass clear golden yellow, or sometimes rusty orange, the elaters simple, long, 4–5  $\mu$  in width, the spirals three or four, closely wound, spinulose, even and regular, the apices short, acuminate; spore-mass concolorous; spores yellow under the lens, covered by a delicate fine-meshed network, often incomplete, appearing simply spinulose under low power, 10–12  $\mu$ . Plasmodium white.

Generally a well-marked species, easily recognized by its regular but roughened capillitial threads. Under an oil immersion objective the spores are also diagnostic. To the unaided eye it resembles *T. persimilis* both in color and habit. Fructifications two inches or more in length and half as wide are not infrequent on the lower side of fallen stems in forests of deciduous trees.

Not uncommon. Maine to Washington, Oregon, Alaska, and south to Missouri and Arkansas. North temperate regions generally. South Africa, Ceylon.

*Trichia asiatica* Skvortz., 1931, is probably this species. The spores are said to be minutely warted, but this is often their appearance under a dry lens.

#### 10. *TRICHIA FAVGINEA* (Batsch) Pers.

Roemer N. Mag. Bot. 1 : 90. 1794.

Pl. XIX, Figs. 504, 505, 506.

1786. *Lycoperdon favogineum* Batsch, Elench. Fung. Cont. 1 : 257, fig. 173 a, b.

1791. *Spharocarpus chrysospermus* Bull., Champ. 131, pl. 417, fig. 4.

1791. *Stemonitis favoginea* (Batsch) Gmel., Syst. Nat. 2 : 1470.

1805. *Trichia chrysosperma* (Bull.) DC., Fl. Fr. 2 : 250.

Sporangia closely crowded, cylindric or prismatic by mutual pressure, obovoid, sessile, 0.6–0.7 mm. in diameter, 0.7–1.6 mm. tall, olivaceous yellow, smooth and shining; peridium thin, opening above somewhat stellately, persistent; capillitium golden yellow, escaping

entirely from the peridia and forming woolly masses above them, the threads long, even, beautifully sculptured, bearing about four spirals, smooth or with scattered short spines and connected by light longitudinal ridges, the apices short-tapering, about equal to the width of the elater, 6–8  $\mu$ ; spores concolorous, by transmitted light paler, but still bright yellow, the episporic net conspicuous, the bands narrow and high, not pitted, in form irregularly globose, 12–14  $\mu$ . Plasmodium yellow.

A common and beautiful species recognizable at sight, after the peridia break, by the aggregate capillitium constantly in evidence above the abandoned vasiform peridia. The figures of Bulliard are unsatisfactory, although the description he gives and the name he suggests, still current, may lead us to concede that he had this species before him. The spores are larger than in *T. persimilis*, and the episporic net different, the "border" wider. The plasmodium, in the latitude of Iowa not uncommon in woods in June, after emerging passes into fruit in the laboratory in about forty-eight hours, and the rupture of the peridia follows. The hypothallus is quite distinct, extra-marginal, and in substance like the peridial wall.

Not rare. Throughout the northern forests, Maine to Washington and Oregon, south to Alabama, Louisiana, Mexico, Chile; Europe, North Africa, Asia.

#### 11. TRICHIA PULCHELLA *Rex*

Proc. Acad. Nat. Sc. Phila. 1893 : 366.

Pl. XIX, Figs. 507, 508, 509.

Sporangia solitary or in groups of four or five, bright vitelline yellow, sessile; peridium thin, transparent, opening irregularly above; hypothallus none; capillitium bright yellow, not emergent, the threads narrow, 3–4  $\mu$ , wound with three or four spirals, more or less irregular, smooth, longitudinal ridges wanting, the apices usually rather long, acuminate, about twice the diameter of the elater, sometimes clavate or even globose, bulbous at the tip and furnished with several stout spines; spore-mass concolorous; spores colorless under the lens, marked by an imperfect pitted reticulation of the *T. persimilis* type, the bands high but narrow, the meshes few and often imperfect, globose or sub-globose, "about 12  $\mu$ ." If the pale but distinct border is taken into account, the spores of typical material sent by Mr. Rex to Dr. Wingate measure 14–17  $\mu$ .

The episporic characters of this species ally it most nearly with *T. persimilis*. The reticulations are possibly not more divergent from the typical form of that species than are the same features in some



other forms there included. But in the present case, added to the episporic sculpture, we must reckon the peculiar capillitial thread, unlike that seen in either of the chrysospermatous forms, and the gregarious habit without hypothallus. These peculiarities seemed to Dr. Rex distinctive, and as they appear constant they may be left to separate the species.

In the English monograph this species is included in *T. affinis* de By. The spores are different, however, and the capillitium more slender. It needs further study, pending which it may be allowed to stand.

Pennsylvania.

## 12. *TRICHIA AFFINIS* de Bary

in Fuckel, Symb. Myc. 336. 1869.

1889. *Trichia intermedia* Masee, Jour. R. Micr. Soc. 341.

1889. *Trichia kalbreyeri* Masee, Jour. R. Micr. Soc. 344.

Sporangia globose or obovoid, sessile, usually crowded, often seated on a membranous hypothallus, 0.6–1 mm. in diameter, ochraceous or shining golden yellow; wall membranous, pale yellow, marked with delicate striæ; capillitium of long, cylindrical elaters, 4–6  $\mu$  wide, with conical pointed ends, smooth or minutely spinulose, and with longitudinal striæ; spores reticulated with broad pitted bands, forming three to five meshes to the hemisphere, 13–15  $\mu$ . Plasmodium watery white.

Mr. Lister thought *T. pulchella* Rex a synonym. This seems doubtful. *Hemitrichia helvetica* Meylan (Bull. Soc. Vaud. Sc. Nat. 46 : 54, 1910) is regarded by Miss Lister as an imperfect development of this species, with a more or less netted capillitium.

Ontario, Montana, Colombia, Bolivia; temperate regions of the old world; Ceylon, Philippines.

## 13. *TRICHIA PERSIMILIS* Karst.

Not. Sællsk. Fenn. Förh. 9 : 353. 1868.

Pl. XIX, Figs. 510, 511.

1875. *Trichia jackii* Rost., Mon. 258.

1877. *Trichia abrupta* Cooke, Ann. Lyc. Nat. Hist. N. Y. 11 : 404.

1879. *Trichia proximella* Karst., Bidr. Kann. Finl. Nat. Folk 34 : 139.

1889. *Trichia balfouri* Masee, Jour. R. Micr. Soc. 339.

1889. *Trichia sulphurea* Masee, Jour. R. Micr. Soc. 339.

Sporangia globose, obovoid or clavate or irregularly spherical, 0.5–0.8 mm. in diameter, shining, golden yellow to tawny, anon iridescent with metallic luster, sessile; hypothallus thin, but usually

very distinct; capillitial mass ochraceous or tawny yellow, the elaters long, even, 4–6  $\mu$  wide, the spirals four, more or less spinulose, generally joined by longitudinal ridges, the apices short, tapering regularly, occasionally bifurcate; spore-mass concolorous; spores by transmitted light bright yellow, marked by an irregular or fragmentary banded reticulation, the bands broad, flat and pitted, 10–13  $\mu$ . Plasmodium said to be white.

This species, common throughout the northern world, is distinguished from *T. favoginea* not only by the episporic character, but generally by its different peridium and more somber colors. It never shows at maturity the brilliant golden yellow fluff that hangs in masses about the open and empty vases of *T. favoginea*, a fact not unnoted by Batsch, and rendering his figure and description of that species so far determinable.

The episporic network shows all degrees of perfection or imperfection, and the elater also varies somewhat both in the apices and the distinctness of the longitudinal striæ. The several synonyms listed seem to have taken origin in a recognition of some of the more pronounced variations. In any event the American form *T. abrupta* Cke., with bifid apices, belongs here, and European specimens seem to show the identity of forms described by Karsten and de Bary.

Not rare. New England, Canada, New York, Pennsylvania, Ohio, Wisconsin, Alabama, Missouri, west to Washington, Peru. Temperate regions generally, also South Africa, Ceylon, Java, Manchuria, Japan.

#### 14. *TRICHIA VERRUCOSA* Berk.

in Hooker, Fl. Tasm. 2 : 269. 1860.  
Pl. XIX, Figs. 512, 513.

1889. *Trichia superba* Massee, Jour. R. Micr. Soc. 345.

Sporangia pyriform or obovoid, shining, large, 2–4 mm. tall, 0.8 mm. broad, ochraceous from the color of the contents, stipitate, more or less botryoid or connate; stipe twice the height of the spore-case, reddish brown, simple or consolidated with others, weak, inclined or procumbent; hypothallus distinct; elaters simple, with smooth tapering points, spirals three or four; spore-mass ochraceous yellow; spores beautifully and strongly reticulate, as in *Trichia favoginea*, with the meshes generally complete and always large, quite variable in size, 12–16  $\mu$ .

Washington, Mexico, West Indies, Brazil, Chile. Originally described from Tasmania, the species is said to occur generally in Australia, also in Great Britain, Portugal, Java, Japan.

15. *TRICHIA ERECTA* *Rex*

Proc. Acad. Nat. Sc. Phila. 1890 : 193.

Pl. XIX, Figs. 514, 515.

Sporangia gregarious, often in clusters of two or three together, but generally single, nut-brown, checkered with broad, conspicuous yellow dehiscence bands, globose, 0.5 mm. wide, stipitate; stipe double the sporangium, dark brown, solid, rather thick; capillitial mass bright yellow, the elaters cylindric, 3-4  $\mu$  wide, terminating in short and smooth apices, spirals four, coarsely spinulose, winding unevenly or branching and so united one to another; spore-mass yellow; spores by transmitted light pale, globose, minutely warted, 11-13  $\mu$ . Plasmodium white.

Distinguished at sight by the peculiar mottled peridium. *T. botrytis* in its ochraceous forms sometimes shows a tendency to the same thing, but the checkered surface is here conspicuous. The elaters resemble those of the preceding form, but are remarkably spiny.

New York, Tennessee, Washington; Europe, Ceylon, Australia.

16. *TRICHIA SUBFUSCA* *Rex*

Proc. Acad. Nat. Sc. Phila. 1890 : 192.

Pl. XIX, Figs. 516, 517, 518.

1894. *Trichia botrytis* Pers. var. *subfusca* (Rex) Lister, Mycetoza 172.

Sporangia gregarious, scattered, dull tawny brown, shading to dark brown below, without lines of dehiscence, about 0.5 mm. in diameter, globose, stipitate; stipe short, about equal to the sporangium, stout, brown or brownish black, rugulose, solid; capillitial mass bright straw color; the elaters long-cylindrical, 3-4  $\mu$  wide, with four spirals, which wind unevenly, are perfectly smooth, and terminate in abrupt tips about twice the diameter of the elater; spores yellow, minutely and closely warted, globose, 11-14  $\mu$ . Plasmodium chocolate brown.

The spores of this species closely resemble those of *T. botrytis*, but the sporangium is at sight different in appearance and proportions and the capillitium not the same at all. The elaters are never fusiform, the apices always abruptly pointed, and the sculpture irregular and uneven. In form the elater resembles that of *T. scabra*.

The elaters of uniform diameter, the apices abruptly narrowed to a blunt point, turned to one side, will serve to distinguish this species from the whole *T. botrytis* group, some forms of which it outwardly resembles. We have beautiful specimens from the shores of Puget Sound.

New York, Washington; Europe, Ceylon.

## 17. TRICHIA DECIPIENS (Pers.) Macbr.

N. A. Slime-Moulds 218. 1899.

Pl. XIX, Figs. 519, 520.

1793. *Lycoperdon pusillum* Hedwig, Abh. 1 : 35, pl. 3, fig. 2, *non* Batsch.  
 1795. *Arcyria decipiens* Pers., Ust. Ann. Bot. 15 : 35.  
 1796. *Trichia fallax* Pers., Obs. Myc. 1 : 59.  
 1803. *Trichia virescens* Schum., Enum. Pl. Sæll. 2 : 208.  
 1814. *Trichia cerina* Ditm., in Sturm, Deutsch. Fl. Pilze 2 : 51, pl. 25.  
 1821. *Trichia fulva* Purt., Midl. Fl. 3 : 290.  
 1886. *Trichia nana* Zukal, Verh. Zool.-Bot. Ges. Wien 35 : 334, pl. 15, fig. 8.  
 1907. *Trichia stuhlmanni* Eichelbaum, Verh. Nat. Ver. Hamb. III, 14 : 32.  
 1907.

Sporangia gregarious, sometimes closely so, sometimes scattered, turbinate, shining olive or olivaceous brown, stipitate; stipe generally elongate, concolorous above, dark brown below, hollow, filled with spore-like cells; capillitial mass yellowish or olivaceous yellow, the elaters perfectly smooth, long-fusiform, tapering gradually to the long, slender apices, simple or often branched, adorned with three to five spirals, which wind evenly but somewhat distantly; spore-mass olivaceous or ochraceous; spores under the lens pale, delicately reticulate over most of the surface, 10-13  $\mu$ .

One of our largest and most common species, in form and size resembling *Hemitrichia clavata*, but immediately distinguished by its color. The capillitium is like that of *T. botrytis*, but differs in the more open sculpture and the longer and smoother unwound tips. The episporic net is a constant character in all the specimens examined. This feature suggests *T. scabra*.

This is, of course, the familiar *T. fallax* of all authors from Persoon down. The earliest unmistakable reference to this species is by Hedwig. But Batsch, in 1789, had used the same combination to describe a real puff-ball, so that Hedwig's name was already a synonym. The specific name here adopted is next in point of priority, although Persoon discarded it the year following, substituting *fallax*, because he had mistaken the genus.

Several varieties and forms have been described, none of which appear in our American collections. See Lister, 1925, p. 212, and Brandza, 1929, p. 280.

Not rare. Nova Scotia, New England, Ontario, west to the Black Hills and Washington, Oregon, California, south to the Carolinas and Kansas, Mexico; Europe, Ceylon.



18. *TRICHIA BOTRYTIS* (Gmel.) Pers.

Roemer N. Mag. Bot. 1 : 89. 1794.  
Pl. XX, Figs. 521, 522.

- 1791. *Stemonitis botrytis* Gmel., Syst. Nat. 2 : 1468.
- 1799. *Trichia serotina* Schrad., Schrad. Jour. Bot. 5 : 67.
- 1803. *Sphaerocarpus fragilis* Sow., Engl. Fung. pl. 279.
- 1837. *Trichia lorinzeriana* Corda, Icon. 1 : 23, fig. 228 D.
- 1859. *Trichia purpurascens* Nyl., Sællsk. Faun. Fl. Fenn. 4 : 126.
- 1875. *Trichia fragilis* (Sow.) Rost., Mon. 246.
- 1889. *Trichia carlyleana* Mass., Jour. R. Micr. Soc. 329.

Sporangia gregarious, scattered, sometimes combined in clusters, pyriform or turbinate, stipitate, red-purple or ochraceous brown, the peridium breaking up irregularly, the dehiscence often prefigured by pale reticulations on the surface; stipe solid, single or united in clusters of five or more together, dark colored, red or purple-brown, opaque; capillitium orange, ochraceous yellow, brick-red or reddish brown, the threads simple or rarely branched, long-fusiform, about  $4\ \mu$  thick at the center, tapering gradually to the long acuminate, apiculate tips, spirals three or four, even, smooth, rather closely wound and traceable almost to the apex; spores concolorous in mass, under the lens pale, globose, minutely warted but not reticulate, 10–12  $\mu$ . Plasmodium typically purple-brown.

Remarkable for its variations in color. More commonly the unopened sporangia are opaque brown, by reason of a dense outer wall, and usually simple, or, if compound, show but two or three united. The reddish phase, vinous or scarlet-black in color, is remarkably fasciate. Some clusters show twenty or more stipitate, globose sporangia, joined by their distinct but coherent stems. In such fruitings the sporangia are small, 0.5 mm. In the brown sporangia the dehiscence, as stated, is often definitely prefigured; in the multiple, red forms obscurely, if at all. As presented in collections from the eastern United States, the two forms might well be disjoined. Persoon, however, discussed both together and so they remain.

From the descriptions of the earlier authors it is impossible to distinguish this from *Hemitrichia vesparium* on the one hand, and *T. decipiens* on the other. *T. botrytis* Pers. gives us first secure foothold. Fries discards Persoon's appellation as unsuitable and improperly applied, and takes up what he deems an older specific designation, *Mucor pyriformis* Leers. But Rostafinski is certain Leers had *Arctyria punicea* in mind, and that other early names are equally ill applied. Rostafinski rejects Persoon's names simply as not pertinent in every case.

Var. *munda* Lister (Jour. Bot. 35 : 216, 1897) is distinguished from the typical form by its smaller size and smooth elaters, with regular, close spiral bands. Meylan adds that its color is constantly fawn or grayish, that it arises from a white instead of a blackish purple plasmodium and that the elaters are of uniform breadth instead of tapering throughout, except for their long tapering ends, which usually arise from an inflation. He recognizes it as a distinct species under the name *T. munda* (Bull. Soc. Vaud. Sc. Nat. 56 : 327, 1927).

Var. *flavicoma* Lister (Mycetozoa 172, 1894) is marked by its small size and solitary purplish brown sporangia. Meylan (l. c.) would make it a variety of his *T. munda*.

Var. *cerifera* G. List. (Jour. Bot. 53 : 211, 1915) bears particles of wax on the sporangia; var. *aurispora* Meylan (l. c.) is marked by its golden yellow spore-mass.

Not common, but very widely distributed. Maine, Ontario, Washington, south to Pennsylvania, Ohio and Colorado. Recorded from all continents.

#### 19. TRICHIA FLORIFORMIS (Schw.) G. List.

Jour. Bot. 57 : 110. 1919.

Pl. XX, Fig. 523.

1832. *Craterium floriforme* Schw., Trans. Am. Phil. Soc. II. 4 : 258.

1846. *Trichia lateritia* Lév., Ann. Sc. Nat. Bot. III. 5 : 167.

1875. *Trichia decaisneana* de B., in Rost., Mon. 250.

1911. *Trichia botrytis* Pers. var. *lateritia* (Lév.) Lister, Mycetozoa ed. 2. 217.

Sporangia stalked or rarely nearly sessile, about 1 mm. in diameter, free and gregarious or adhering in clusters of 2-6 or rarely more, obovate or globose-turbinate, deep purplish brown, becoming dull black; stipes even, concolorous, free from refuse matter, when united closely adherent or combined; hypothallus small or lacking; capillitial mass bright brick-red; elaters fusiform, long, ending in long tapering points and encircled by usually four spiral bands; spores brick-red in mass, orange-brown by transmitted light, almost smooth, 10-12  $\mu$ . Plasmodium purple-brown.

Superficially resembling *Hemitrichia vesparium* but quite different in its internal structure. Differing from *Trichia botrytis* in its darker sporangium wall, brighter, translucent stalk and in its method of dehiscence. This is irregular in *T. botrytis*, usually petaloid in *T. floriformis*, leaving a deep cup which induced Schweinitz to place it among the crateriums.

Widely distributed but not common in North America, where it is

mainly a Pacific coast form. Also known from Chile and Venezuela. Said to be common in Europe. Ceylon.

#### 4. *Hemitrichia* Rost.

Versuch 14. 1873.

1875. *Hemiarcyria* Rost., Mon. 261.

Capillitium a tangled net of more or less branching and anastomosing fibers centrally attached; the sculpture regular, of conspicuous spirally winding bands or ridges; habit and color various.

The species here associated are intermediate between *Arcyria* and *Trichia*, resembling the former in the capillitial net and the latter in thread-sculpture. Fries applied the name *Hemiarcyrieæ* to a group of trichias so-called, citing *T. rubiformis* as the first. In his "Versuch" Rostafinski wrote *Hemitrichia* and afterward, in the Monograph, *Hemiarcyria*. Massee combines the genera *Arcyria* and *Hemiarcyria* under the former name.

#### KEY TO THE SPECIES OF HEMITRICHIA

- |  |                          |
|--|--------------------------|
| a. Fructification plasmodiocarpous.....  | b                        |
| a. Sporangia usually distinct, rarely somewhat plasmodiocarpous.....                   | c                        |
| b. Plasmodiocarps net-like, yellow; spores reticulated.....                            | 1. <i>H. serpula</i>     |
| b. Plasmodiocarps shorter, brown; spores warted.....                                   | 2. <i>H. karstenii</i>   |
| c. Sporangia sessile or very short stalked.....  | d                        |
| c. Sporangia with distinct, usually long stalks.....                                   | i                        |
| d. Spores reticulated, over 14 $\mu$ .....   | 3. <i>H. chrysospora</i> |
| d. Spores minutely warted or nearly smooth.....  | e                        |
| e. Copper colored or reddish to deep brown; spiral bands often faint or irregular..... | 4. <i>H. stipata</i>     |
| e. Copper colored, fading to tawny yellow; bands distinct and regular.....             | 5. <i>H. imperialis</i>  |
| e. Without copper or red tints.....  | f                        |
| f. Pallid or whitish.....  | 6. <i>H. montana</i>     |
| f. Yellow or ochraceous.....   | g                        |
| g. Peridium hyaline, iridescent.....   | 7. <i>H. ovata</i>       |
| g. Peridium opaque.....  | h                        |
| h. Minute, under 0.4 mm. diameter, usually sessile, sometimes plasmodiocarpous.....    | 8. <i>H. minor</i>       |
| h. Larger, usually with short, thick stipe.....  | 9. <i>H. leiotricha</i>  |
| i. Deep red.....   | 10. <i>H. vesparium</i>  |
| i. Pallid, yellow or yellow-brown.....   | j                        |
| j. Stalk solid; capillitium distinctly spiny.....                                      | 11. <i>H. intorta</i>    |
| j. Stalk hollow, filled with spore-like cells; capillitium smooth or nearly so.....    | k                        |
| k. Pallid or grayish ochraceous; spirals of capillitium sinistrorse                    | 12. <i>H. leiocarpa</i>  |
| k. Olivaceous yellow to bright yellow-brown; spirals of capillitium dextrorse.....     | l                        |

- l. Stalk expanding upward, gradually merging into the deep calyculus; capillitium loose, rough, with free ends usually evident; spores coarsely papillate or subreticulate. . . . . 13. *H. clavata*
- l. Stalk cylindrical, ending abruptly below the shallow calyculus; capillitium dense, nearly smooth, with few or no free ends; spores minutely spinulose or faintly reticulate . . . . . 14. *H. stipitata*

## 1. HEMITRICHIA SERPULA (Scop.) Rost.

Versuch 14. 1873.

Pl. XX, Figs. 524, 525, 526.

1772. *Mucor serpula* Scop., Fl. Carn. ed. 2. 2 : 493.  
 1786. *Lycoperdon lumbricale* Batsch, Elench. Fung. Cont. 1 : 259, fig. 174 a-c.  
 1789. *Trichia spongioides* Vill., Fl. Dauph. 1061.  
 1791. *Stemonitis lumbricalis* (Batsch) Gmel., Syst. Nat. 2 : 1470.  
 1797. *Trichia reticulata* Pers., Tent. Disp. 10.  
 1797. *Trichia serpula* (Scop.) Pers., Tent. Disp. 10.  
 1803. *Trichia venosa* Schum., Enum. Pl. Sæll. 2 : 207.  
 1842. *Hyporhamma reticulatum* (Pers.) Corda, Icones 5 : 13, pl. 2, fig. 34.  
 1850. *Trichia retiformis* Payer, Bot. Crypt., fig. 574.  
 1875. *Hemiarcyria serpula* (Scop.) Rost., Mon. 266.  
 1892. *Arcyria serpula* (Scop.) Mass., Mon. 164.

Fructification plasmodiocarpous, often covering several square centimeters, terete, branching freely and usually everywhere reticulate, rusty, tawny or bright yellow; peridium thin, transparent, with irregular, longitudinal dehiscence; hypothallus like peridium or a little darker, the margins between adjoining segments often separated by a black line; capillitium variable, a tangle of long yellow threads, sparingly branched, free everywhere except below, spinulose, the free tips spinose, acuminate, spiral ridges three or four, with traces of longitudinal striæ; spore-mass golden yellow, spores beneath the lens pale yellow, globose, coarsely reticulate, 11-16  $\mu$ .

Very common, recognized by its bright yellow color and conspicuous reticulate habit. The plasmodium is at first milky white, becoming yellow. Found on rotten logs of every description, on the lower surface.

Common west to the Rocky Mountains and Washington, south to Mexico, Nicaragua, Colombia, Bolivia and Brazil. Also Europe, South Africa, Manchuria, Japan and generally in the tropics.

## 2. HEMITRICHIA KARSTENII (Rost.) List.

Mycetozoa 178. 1894.

Pl. XX, Figs. 543, 544.

1876. *Hemiarcyria karstenii* Rost., Mon. App. 41.  
 1889. *Hemiarcyria paradoxa* Masee, Jour. R. Micr. Soc. 356.



1891. *Hemiarcyria obscura* Rex, Proc. Acad. Nat. Sc. Phila. 395.

1892. *Arcyria paradoxa* Masee, Mon. 160.

1892. *Arcyria karsteni* (Rost.) Masee, Mon. 168.

Fructification plasmodiocarpous, with a tendency to form distinct sessile, globose sporangia, 0.3–0.5 mm. broad, color brownish red; capillitium a sparingly branched network, with free ends few, the threads marked by seven or eight faint spirals, the interspaces narrow, dull red in color and  $2.5\ \mu$  in diameter; spores yellow, delicately warted,  $10\text{--}12\ \mu$ .

This is doubtless a very rare species. In the description we have followed Dr. Rex, as being more to the point for American forms. It is not improbable that the American material may after all be distinct, as discrepancies, if one may judge by descriptions, are not few. Lister, who had a slide from Dr. Rex, considers the European and American forms the same.

In outward appearance, plasmodiocarpous phases of this species very closely resemble forms of *Licea* or *Ophiotheca*, and are in consequence often wrongly labelled.

Ontario, Colorado, Montana, Washington; Europe, Ceylon, Japan.

### 3. HEMITRICHIA CHRYSOSPORA *Lister*

Mycetozoa 180. 1894.

Sporangia sessile, crowded or scattered, subglobose or forming short plasmodiocarps, 0.5–1 mm. in diameter, bright yellow, glossy; peridium membranous, with granular thickenings; capillitium a network of branching yellow threads,  $4\text{--}5\ \mu$  in diameter, with four or five narrow, close spirals connected by longitudinal striæ, the threads often attached to the sporangium wall and with many short, pointed free ends; spores yellow, strongly reticulated with narrow, prominently raised bands, forming 6–9 meshes to the hemisphere,  $14\text{--}18\ \mu$ , the border  $1.5\text{--}2\ \mu$  wide.

Said to be closely allied to *Trichia verrucosa*.

England, Germany.

### 4. HEMITRICHIA STIPATA (*Schw.*) *Macbr.*

N. A. Slime-Moulds ed. 2. 262. 1922.

Pl. XX, Figs. 527, 528, 529.

1832. *Leangium stipatum* Schw., Trans. Am. Phil. Soc. II. 4 : 258.

1876. *Hemiarcyria stipata* (Schw.) Rost., Mon. App. 41.

1894. *Arcyria stipata* (Schw.) List., Mycetozoa 189.

Sporangia crowded, short-stipitate or nearly sessile, 1.5–2 mm. tall, erect or more or less superimposed, in fresh collections copper colored

or reddish, metallic, changing to a deep brown in older specimens, often with lavender or rose tints; hypothallus dark brown, common to a cluster of sporangia; stipe 0.1–1 mm. tall, brown, hollow, the cavity filled with spore-like cells; peridium evanescent above, breaking away until only a shallow disk-like calyculus remains, or sometimes persistent as four or five lobes where sporangia have been crowded; capillitium concolorous, somewhat elastic, forming a loose net, with bulbous thickenings and free ends more or less frequent, threads 3–5  $\mu$  wide, marked with three or four spirals, these often obscure on the inside of curves and sometimes elsewhere, and projecting on the outside of curves to form pointed protuberances; spores pallid, globose, nearly smooth, often marked with very fine papillæ appearing like concentric stippling under an oil immersion objective, with occasional larger warts, 6–8  $\mu$ .

Mr. Lister placed this species in *Arcyria* because of the indistinctness of the spirals in parts of the capillitium, the somewhat elastic capillitium and the persistent calyculus. In our material the spiral markings are usually quite distinct and present on the greater part of the capillitium. Since a persistent calyculus and a somewhat elastic capillitium characterize some hemitrichias as well as arcyras it seems that the present species, while undoubtedly a border form, may best be retained in *Hemitrichia*.

Uncommon. Nova Scotia to Ontario and Washington, south to Mexico; Europe, southern Asia, Japan, Fiji.

##### 5. *HEMITRICHIA IMPERIALIS* Lister

Trans. Brit. Myc. Soc. 14 : 226. 1929.

Sporangia clustered, short-stalked or sessile, cylindrical, curved, 0.8–1.5 mm. tall, pale copper colored, fading to dull tawny yellow; sporangium walls more or less persistent, nearly smooth or marked with transverse wrinkles below; stalk nearly black, attaining 0.3 mm., filled with spore-like cells; capillitium of sparsely branched, flexuose threads, 4–4.5  $\mu$  broad, unattached to the sporangium walls and with few free ends, marked with three or four prominent, sinistrorse, smooth or spiny spiral bands; spores pale copper colored or dull yellow in mass, smooth or marked with a few faint scattered warts, 6.5–7  $\mu$ . Plasmodium milk-white.

Obviously close to *H. stipata*.

Japan.

6. *HEMITRICHIA MONTANA* (*Morgan*) *Macbr.*

N. A. Slime-Moulds 208. 1899.

Pl. XX, Figs. 541, 542.

1895. *Hemiarcyria montana* Morg., Jour. Cin. Soc. Nat. Hist. 18 : 40.

Sporangia scattered or more or less closely gregarious, globose, whitish, sessile or very short-stipitate; peridium opaque, dull white, persistent below; capillitium deep yellow, the threads abundantly branched, forming a compact network,  $7\ \mu$  wide, spirals five or six, uneven and irregular, or anon interrupted, conspicuously spinulose or warted, free tips not lacking, generally inflated; spore-mass yellow; spores by transmitted light pale, nearly colorless, distinctly warted,  $10\text{--}12\ \mu$ .

Recognizable by its peculiar pallid, sessile sporangia, as by the internal structure. Miss Lister includes this species in *H. clavata*.

Common throughout the southwestern states to southern California.

7. *HEMITRICHIA OVATA* (*Pers.*) *Macbr.*

N. A. Slime-Moulds ed. 2. 261. 1922.

Pl. XX, Figs. 530, 531, 532.

1796. *Trichia ovata* Pers., Obs. Myc. 1 : 61.1863. *Trichia abietina* Wigand, Prings. Jahrb. 3 : 33, pl. 2, fig. 11.1875. *Hemiarcyria wigandii* Rost., Mon. 267.1892. *Arcyria wigandii* (Rost.) Massee, Mon. 163.1911. *Hemitrichia abietina* (Wigand) Lister, Mycetozoa ed. 2. 227.

Sporangia crowded or sometimes closely gregarious, subglobose or turbinate, about 0.5 mm. in diameter, shining yellow, sessile; peridium thin, iridescent; capillitium a tangle of sparingly branched yellow or ochraceous yellow threads, rather slender,  $3\text{--}5\ \mu$ , marked by one or two prominent spiral bands forming a loose, somewhat irregular spiral, the free ends not infrequent, inflated and rounded; spore-mass yellow or yellow ochraceous; spores by transmitted light pale yellow, distinctly and sharply spinulose, but not netted,  $10\text{--}11\ \mu$ .

A rare and beautiful species, distinguished well by the small size, the thin iridescent peridium, and the microscopic characters of the capillitial threads.

There is no doubt that this is Persoon's *Trichia ovata*. His description is accurate in all that pertains to external features, and Rostafinski (Mon. App. 41) explicitly says that he saw in Persoon's herbarium specimens of the species bearing the name cited. Just why Rostafinski did not here adopt the older name is not clear, nor is there excuse for

abandoning Wigand's name were Persoon's invalid. According to Lister, *Trichia nana* Mass., from Maine, is the same thing, but this is not clear from the description. Persoon gives a synonymy which, in the nature of the case, is unverifiable, the specific characters being microscopic.

Fries (Syst. Myc. 3 : 187) confirms Persoon and takes pains to say that the color separates it from *T. chrysosperma* (i. e., *T. favoginea*) with which it is sometimes compared.

Rare. Maine, Massachusetts, New York, Ohio, Ontario; Europe, Japan.

#### 8. HEMITRICHIA MINOR G. Lister

Jour. Bot. 49 : 62. 1911.

Pl. XXI, Figs. 561, 565.

Sporangia short-stalked or sessile, subglobose, occasionally united or forming short plasmodiocarps, 0.2–0.4 mm. in diameter, glossy or pale yellowish buff; sporangium wall membranous, pale yellow, minutely papillose or marked with faint curved lines, and bearing superficial deposits of granular material; stalk, when present, black, 0.1–0.2 mm. tall, enclosing refuse matter; capillitium a loose, flaccid network, the spirals sinistorse, faint, with or without spines; spores pale yellow, minutely warted, 9–10  $\mu$ .

The var. *pardina* Minakata (Trans. Br. Myc. Soc. 5 : 82, 1914) has more numerous granules on the peridium; the spirals are said to be dextrorse.

The spirals are so faint that this species would seem to be better accommodated in *Ophiotheca* or *Perichæna*. In all American specimens the spines are well developed. We are indebted to Miss Lister for the determination of our material. The variety is externally so different from the typical form as to suggest a distinct species but intermediate forms occur. In general the variety tends to be stalked and the typical form sessile or plasmodiocarpous. Our specimens all developed on bark, dung or dried grass and litter in moist chambers.

Ontario, Iowa; Great Britain, Japan.

#### 9. HEMITRICHIA LEIOTRICHIA Lister

Mycetozoa ed. 2. 224. 1911.

1894. *Hemitrichia intorta* Lister var. *leiotricha* Lister, Mycetozoa 176. 1894.

Sporangia short-stalked, rarely sessile, scattered, subglobose, shining dull yellow or olivaceous, 0.5–0.9 mm. in diameter; peridium usually composed of a translucent inner portion marked with scattered



ring-shaped or crescentic thickenings, the outer portion composed of scattered deposits of brown refuse matter; stalk dark brown or black, 0.1–0.3 mm. tall; capillitium a tangle of sparingly branched, smooth, yellow threads, 3–4  $\mu$  wide, with few or many, round or pointed free ends, marked with three to six often faint spiral bands; spores yellow or olivaceous, minutely warted, 9–13  $\mu$ .

Europe, Ceylon. Brandza says America, but no collections are known to us from either North or South America.

#### 10. HEMITRICHIA VESPARIUM (Batsch) Macbr.

N. A. Slime-Moulds 203. 1899.

Pl. XX, Figs. 533, 534, 535.

1786. *Lycoperdon vesparium* Batsch, Elench. Fung. Cont. 1 : 253, fig. 172.

1790. *Trichia pyriformis* Hoffm., Veg. Crypt. 2 : 1, pl. 1, fig. 1.

1791. *Stemonitis vesparia* (Batsch) Gmel., Syst. Nat. 2 : 1470.

1792. *Trichia fragiformis* With., Br. Pl. ed. 2. 3 : 480.

1794. *Trichia rubiformis* Pers., Roem. N. Mag. Bot. 1 : 89.

1826. *Trichia chalybea* Chev., Fl. Paris 1 : 323.

1837. *Trichia neesiana* Corda, Icon. 1 : 23.

1850. *Trichia ayresii* Berk. & Br., Ann. Mag. Nat. Hist. II. 5 : 367.

1875. *Hemiarcyria rubiformis* (Pers.) Rost., Mon. 262.

1892. *Arcyria rubiformis* (Pers.) Massee, Mon. 158.

1894. *Hemitrichia rubiformis* (Pers.) List., Mycetozoa 175.

Sporangia clustered or crowded, rarely single, clavate or subcylindrical, 1–1.3 mm. tall, 0.5–0.7 mm. in diameter, stipitate or occasionally sessile, dark wine red or red-black in color, the peridium in perfect specimens glossy or shining metallic, opaque; stipes solid, usually blent together, concolorous; capillitium of intertwined threads, 5–6  $\mu$  in diameter, sparingly branched, marked by three or four spiral ridges, abundantly spinulose, the free tips acuminate, terminating in a spine, the whole mass dull red. Spore-mass brownish red; spores by transmitted light reddish orange, warted, subglobose, 10–12  $\mu$ .

A most common species, on rotten wood everywhere, especially in forests. Recognized generally at sight by its color and fasciculate habit. The peridium often shows a tendency to circumscissile dehiscence, and persists long after the contents have been dissipated, in this condition suggesting the name applied by Batsch, *vesparium*, wasp nest. The capillitium is remarkably spinescent, the branching of the threads rare. Rostafinski describes the spores as smooth; they are usually distinctly warted. The plasmodium is deep red, and a plasmodiocarpous fructification occasionally appears.

New England to Ontario, Washington and Oregon, south to the West Indies, Nicaragua, Bolivia and Brazil. Cosmopolitan.

11. *HEMITRICHIA INTORTA* Lister

Mycetozoa 176. 1894.  
Pl. XX, Figs. 547, 548.

1891. *Hemiarcyria intorta* Lister, Jour. Bot. 29 : 268, pl. 312, fig. 3.

Sporangia gregarious, globose-turbinate or pyriform, 0.3–0.7 mm. broad, golden yellow, stipitate; peridium thin, translucent, shining, opening at the summit irregularly, leaving a funnel-shaped receptacle below; stipe dark red-brown, solid, rugulose; capillitium of threads sparingly branched, but looped and doubled upon themselves and constantly intertwined, orange-yellow, 3–4  $\mu$  in diameter, with four spirals, sparingly spinulose, even and regular, the longitudinal striæ conspicuous; spores in mass concolorous, under the lens yellow, delicately warted, globose, 8–10  $\mu$ .

Outwardly the open sporangium, by the projecting free tips, reminds one of a trichia. The capillitium is like that of *H. vesparium*, but less rough, and, of course, different in color.

*H. longifila* Rex (Proc. Phil. Acad. 1891, 396), heretofore regarded as a synonym of this species, is considered by Mr. Hagelstein to be based upon a poorly developed collection of *H. clavata*.

Rare. Ontario, Ohio, Iowa; England, Ceylon.

12. *HEMITRICHIA LEIOCARPA* (Cooke) Lister

Mycetozoa 177. 1894.  
Pl. XX, Figs. 545, 546.

1877. *Hemiarcyria leiocarpa* Cooke, Ann. Lyc. Nat. Hist. N. Y. 11 : 405.

1884. *Lachnobolus rostafinskii* Racib., Rozpr. Mat. Przyr. Ak. Krak. 12 : 80.

Sporangia gregarious, simple, stipitate, subglobose, ovate or obovate, pallid or ochraceous, 0.5–0.7 mm. in diameter; sporangium wall thin, membranous, persistent below; stalk about equal to height of sporangium, concolorous, filled with spore-like cells; capillitium forming a loose net, spirals three to five, sinistrorse, thin, prominent, often more or less spiny; spores globose, pale, appearing nearly smooth under a dry objective but under an oil immersion lens seen to be covered with flat, colorless warts, 7–9  $\mu$ .

Cooke's original description gives the spore-size as 12.5–14  $\mu$ ; Lister says 6–8  $\mu$ ; those of our specimens are somewhat larger than noted by Lister. The Lister monograph emphasizes the "dextrorse" spirals of the capillitium, apparently meaning sinistrorse as previously defined in this work (p. 277). But the figure given is far from conclusive in this respect. The spirals in our material are somewhat irregular and

somewhat netted, but the main threads are sinistrorse, as in the threads of a screw.

Rare. Maine, Pennsylvania, Ontario; Europe.

13. *HEMITRICHIA CLAVATA* (Pers.) Rost.

Versuch 14. 1873.

Pl. XX, Figs. 536, 537, 538.

1794. *Trichia clavata* Pers., Roemer N. Mag. Bot. 1 : 90.

1875. *Hemiarcyria clavata* (Pers.) Rost., Mon. 264.

1892. *Arcyria clavata* (Pers.) Massee, Mon. 165.

1893. *Hemiarcyria ablata* Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 24.

1893. *Hemiarcyria funalis* Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 26.

Sporangia clavate or pyriform, olivaceous yellow, 1–2 mm. tall; hypothallus thin, dark reddish brown; stipe 0.5–1 mm., yellow above shading into reddish brown below, attenuated downwards, hollow, filled with spore-like cells; peridium shining, breaking open irregularly at the top, up to two-thirds remaining as a goblet-shaped calyculus, rather coarsely papillose or with broken reticulations within; capillitium bright yellow or somewhat olivaceous, forming a loose network, the threads 4.5–6.5  $\mu$  thick, closely wound with four or five spirals, minutely spinulose, appearing rough under an oil immersion lens, apices not numerous, often swollen, obtuse, often tipped with a broad-based apiculus 2–4  $\mu$  long; spores pale yellow, globose or subglobose, coarsely papillate, the papillæ frequently elongated into ridges which form a more or less complete reticulation, so that the surface is often partly reticulate, partly papillate, 7–9  $\mu$ .

Common and world-wide in its distribution.

14. *HEMITRICHIA STIPITATA* (Massee) Macbr.

N. A. Slime-Moulds 207. 1899.

Pl. XX, Figs. 539, 540.

1889. *Hemiarcyria stipitata* Massee, Jour. R. Micr. Soc. 354.

1892. *Arcyria stipitata* Massee, Mon. 163.

1893. *Hemiarcyria plumosa* Morgan, Jour. Cin. Soc. Nat. Hist. 16 : 23.

Sporangia gregarious, scattered, seldom crowded, globose or turbinate, olivaceous yellow, stipitate, 1–3 mm. tall; hypothallus thin, dark reddish brown, stipe reddish brown, 0.5–2 mm., rugulose, hollow, filled with spore-like cells, slender, usually uniform in diameter and color from base to apex, often nodding a little at maturity; peridium thin, dull yellow, opening above, one-half or less persistent as a shallow petaloid calyculus which is finely papillate or delicately reticulate within; capillitium yellow, dense, free ends rare, obtuse and not

swollen when present, the threads 5–6.7  $\mu$  in thickness, with four or five spirals, smooth or nearly so; spores yellow, globose, minutely spinulose or delicately reticulate, 7–8  $\mu$ .

In the English monograph this is united with *H. clavata*. Miss Baskerville (1932), who has carefully compared the two species points out that in *clavata* the fructification is clavate or pyriform, with expanding stipe and two-thirds of the peridium remaining to form the calyculus, while in *stipitata* the fructification is globose or turbinate, with uniform stipe and less than half the peridium remaining as a calyculus. The capillitium of *clavata* is loose and finely spinulose with free ends usually evident, while that of *stipitata* is dense, nearly smooth and with few or no free ends. The spores of *clavata* are coarsely warted or subreticulate, those of *stipitata* minutely spinulose or very delicately reticulate.

Common in the eastern United States and Canada and widely distributed throughout northern temperate regions; British Honduras, Java, Liberia.

#### 5. *Calonema Morgan*

Jour. Cin. Soc. Nat. Hist. 16 : 27. 1893.

Sporangia sessile, subglobose or irregular, crowded and superimposed; hypothallus usually not evident; capillitium a network of branching threads arising from the base of the sporangium, the surface marked with an irregular reticulation; spores yellow.

Related to both *Hemitrichia* and *Oligonema*, distinguished from the first by the markings on the capillitium and from the second by the capillitial net.

A single species:

#### CALONEMA AUREUM *Morg.*

Jour. Cin. Soc. Nat. Hist. 16 : 27. 1893.

Pl. XX, Figs. 549, 550, 551.

Sporangia crowded or heaped in scattered clusters; peridium thin, golden yellow, adorned with intricate radiating veinlets; capillitium of threads more or less branched, attached below, free above, the surface to the very tips venulose, interrupted with rings or fragmentary spirals, the apices bulbous and obtusely conical; spore-mass yellow; spores globose, by transmitted light bright yellow, reticulate as in *Trichia favoginea*, 14–16  $\mu$ .

Ohio, South Carolina, Maryland, Alabama, Illinois, Minnesota, Arkansas.



## SUPPLEMENTARY NOTES

The taxonomy of the slime molds cannot be regarded as established, either with reference to the general outlines of the treatment of the group as a whole or to the detailed application of specific names. In the present work, as stated in the introduction, the attempt has been made to apply specific names in accordance with the International Rules of Botanical Nomenclature as revised at Cambridge in 1930. Unfortunately, at the present writing, three and one-half years after the Cambridge meeting, the revised rules have not been published and it has been necessary to depend upon the printed "Proceedings," which are far from clear in indicating modifications of the earlier code. Aside from this circumstance, the difficulties in the way of applying rules consistently are sufficiently great in any case, but peculiarly so in the case of forms like the Myxomycetes. The great majority of the commoner species were described by the older students of the fungi, sometimes exceedingly vaguely, to be sure, but not seldom with remarkable vividness. It is only since the time of de Bary and Rostafinski, however, that stress has been placed upon microscopic characters, and these, which have come to be regarded as of the utmost significance, are almost wholly ignored in the older descriptions. In view of the tentative nature of much of the synonymy cited, it has seemed desirable to err on the side of conservatism and retain widely recognized names in a number of cases where, on the face of the record of synonymy, a change is demanded. Many of these cases are referred to in the text. Certain others may be mentioned here.

*Badhamia rubiginosa* (Chev.) Rost. (p. 38), was originally described by Chevallier in 1826 as *Physarum rubiginosum*. This name had, however, been applied by Fries in 1817 to a different and still valid species (p. 51) and hence was invalid from the beginning according to any rules. The specific name as applied to a *Badhamia* is appropriate and in general use, and the application of the later synonymy is by no means certain. It might well be conserved.

*Physarum aureum* Brandza, 1929 (p. 49), revives a name originally applied by Persoon in 1794 to what he himself called the following year *Physarum viride*, based on Bulliard's *Sphaerocarpus viridis* of 1791, which name is now generally accepted. The rules do not permit the combination Brandza proposed. His species, however, needs further study, pending which, the name he gave it may be permitted to stand.

*Physarum lilacinum* Sturgis & Bilgram, 1917 (p. 68), is preëmpted by *P. lilacinum* Fries, 1829, universally recognized as applying to *Badhamia lilacina* (Fr.) Rost. Known thus far only from the two collections referred to by the authors, if found to be constant it must receive a new name.

*Didymium complanatum* (Batsch) Rost., 1875 (p. 107), is preëmpted by *D. complanatum* Schrad., 1797, which may possibly refer to a sessile phase of *D. melanospermum* (Pers.) Macbr., as Lister suggests, or to something quite different. It is also preëmpted by Fuckel's use of the binomial in 1869 for what is usually called *Diderma radiatum* (L.) Morg. (p. 136).

*Tubifera stipitata* (Berk. & Rav.) Macbr. (p. 233), is based on *Licea stipitata* Berk. & Rav. 1860. But DeCandolle had used that combination in 1815 for *Didymium squamulosum*, hence the next name in point of priority, namely *Licea microsperma* Berk. & Curt. 1873, should furnish the specific epithet, unless the commonly used name be conserved.

*Oligonema nitens* (Lib.) Rost. 1875 (p. 279) is based on *Trichia nitens* Libert, 1834. But *Trichia nitens* Persoon, 1796, applies to a different species, perhaps *T. favoginea*. The next oldest name is *Physarum schweinitzii* Berk., 1873, which would provide the valid specific name according to a strict application of the rules. *Nitens* is generally used, is eminently suitable and might well be conserved.

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H. C. Gilbert has recently made a careful study of *Ceratiomyxa* under the direction of the junior author (Thesis, State Univ. Iowa, 1933) and concludes that the so-called spore is homologous with the sporangium of many of the *Myxogastres*, while the sporophores are equivalent to the hypothallus. He shows that germination of the 4-nucleate spore takes place by the gradual emergence of the protoplast, which expands and remains in globose or slightly irregular form for up to an hour, becoming transformed into an elongated "thread" phase which may persist for several hours. The globose shape is again assumed and the nuclei become grouped in regular tetrahedral fashion. Cleavage occurs and four uninucleate segments are formed directly. Each segment now divides into two, so that eight cells are present in the group, each of which develops a flagellum. The swarm-cells break away from the groups and swim singly, increasing somewhat in size, but give no evidence of division. Eventually fusion of swarm-cells occurs. This may involve two or more swarm-cells, as in *Reticularia*, but nuclear fusion is always between pairs of nuclei of unlike reaction. In *Ceratiomyxa*, this unlikeness is distinctly mani-

fest in the passage of one nucleus through the combined protoplasm of the zygote to join the other, which remains in place.

It is obvious that *Ceratiomyxa* must be regarded, not as primitive, but as a highly specialized genus, the relationships of which with the *Myxogastres*, while apparent, cannot at present be more particularly indicated.

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In the discussion of *Diachea cerifera* G. List. (p. 150) it is noted that this species does not seem to belong in the genus to which it is assigned, and it is suggested that it might better be placed in *Leptoderma*. Meylan (Bull. Soc. Vaud. Sci. Nat. 58: 82, 1933) transfers the species to *Diacheopsis* as *D. cerifera* (G. List.) Meyl. This may prove to be an acceptable solution of the problem of its disposition.

## APPENDIX

### NAMES NOT INCLUDED IN TEXT

The following list contains additional synonyms, names of species not Myxomycetes which have been included in Myxomycete genera and names of uncertain application, the last listed without comment. An attempt has been made to make the list reasonably complete so far as combinations in genera recognized in this work are concerned. Many Myxomycetes are referred in the older literature to such genera as Mucor, Lycoperdon, Clathrus, etc., which are not Myxomycete genera, and many more are listed in such Myxomycete genera as Tilmadoche, Spumaria, Sphærocarpus, Chondrioderma, etc., here discarded. For these the list is much less complete and fuller information must be obtained by consulting Saccardo, Rostafinski and the older lists.

Some of the names listed as doubtful are assigned to definite species in the Lister monograph; many are so assigned by Rostafinski.

<i>Æthaliium melænum</i> Chev. = <i>Lindbladia effusa</i>	<i>Arcyria leiocarpoides</i> (Speg.) Mass.
<i>Arcyrella decipiens</i> Racib. = <i>Arcyria ferruginea</i>	<i>A. melanocephala</i> Schum.
<i>Arcyria affinis</i> Rost.	<i>A. minor</i> Schw.
<i>A. albipes</i> Opiz	<i>A. olivacea</i> Rausch
<i>A. atra</i> Schum.	<i>A. raciborskii</i> Berl.
<i>A. bonariensis</i> Speg.	<i>A. ramulosa</i> Wigand—Not a Myxomycete
<i>A. bucknalli</i> Mass.	<i>A. rosea</i> Spreng.
<i>A. calyculata</i> (Speg.) Mass.	<i>A. rufa</i> Schum.
<i>A. chrysospora</i> (List.) Mass. = <i>Hemitrichia chrysospora</i> List.	<i>A. similis</i> Racib.
<i>A. cincta</i> Schum.	<i>A. straminea</i> Wallr.
<i>A. coccinea</i> Duby	<i>A. trichioides</i> Rudol.
<i>A. cylindrica</i> Schum.	<i>A. umbrina</i> Schum.
<i>A. dentata</i> Schum.	<i>A. vermicularis</i> Schum.
<i>A. flexuosa</i> Rabenh.	<i>A. violacea</i> "Fl. Dan."
<i>A. fulva</i> Rænsch—Not a Myxomycete	<i>A. viridis</i> Zoll.—Not a Myxomycete
<i>A. fusca</i> Fr.	<i>Badhamia alexandrowiczii</i> Rost. = <i>B. nitens</i> var. <i>reticulata</i>
<i>A. glomerata</i> Fr.	<i>B. carnea</i> Oudem.—Not a Myxomycete
<i>A. hariotii</i> Mass. = <i>Lachnobolus congestus</i>	<i>B. citrinella</i> Čel.
<i>A. leiocarpa</i> (Cke.) Mass. = <i>Hemitrichia leiocarpa</i>	<i>B. fasciculata</i> (Jungh.) Rost.
	<i>B. fulvella</i> Berk.



*Badhamia fulvescens* Cke.—Not a Myxomycete

*B. incarnata* Oudem.—Not a Myxomycete

*B. iowensis* Macbr.—A Physarum, perhaps a pallid phase of *P. auriscalpium*

*B. irregularis* Cke. & Ell.

*B. penetralis* Cke. & Ell.

*B.?* *pulcherrima* Speg.

*Ceratiomyxa sphaerospora* Skup.

*Chondrioderma contextum* (Pers.) Rost. = *Physarum contextum*

*C. exiguum* Racib. = *Physarum viride*

*Clathroptychium dissiliens* (Hazzl.) Mass. = *Dictydiaethalium plumbeum*

*Comatricha alta* Preuss

*C. dictyospora* Čel. fil. = *Stemonitis virginienensis*

*C. equinoctialis* Torr. = *C. longa*

*C. gracilis* Wing. = *C. pulchella* var. *gracilis*

*C. papillata* (Pers.) Schroet.

*Cornuvia anomala* Karst.

*C. dictyocarpa* Krupa = *Perichæna corticalis*

*C. leocarpoides* Speg.

*Craterium curtisii* (Berk.) Mass.

*C. flavum* Fr. = *Physarum sulphureum*

*C. leucostictum* (Chev.) Fr.

*C. pendulum* Fr.

*C. porphyrium* Schw.

*C. pruinatum* Corda

*Cribraria badia* Chev.

*C. candida* Rabenh.

*C. capillaris* Fr.

*C. coccinea* (Bull.) Pers.

*C. colossæ* Speg.

*C. didermoides* Schum.

*C. elata* Mass. = *C. tenella*

*C. onygena* Schum.

*C. stellata* Schum.

*C. variabilis* Ficin. & Schub.

*C. venosa* (Schrad.) Pers.

*Diachæa fulgens* Fr. ex Weinm.

*D. hookeri* Mass.

*Dictydium coccineum* Schlecht.

*D. didermoides* (Schum.) Fr.

*D. micropus* Fr.

*Dictydium trichioides* (Bull.) Fr. = *D. cancellatum*

*D. venosum* Schrad.

*Diderma acuminatum* Schum.

*D. chalybeum* Weinm.

*D. contortum* Hoffm.

*D. depressum* Fr.

*D. flavum* Fr.

*D. granulatum* (Schum.) Fr.

*D. hookeri* Berk.

*D. liceoides* Fr.

*D. lobatum* Somm.

*D. minutum* (Schum.) Fr.

*D.?* *ramosum* (Gmel.) Pers.—Probably not a Myxomycete

*D. ramosum* (Schum.) Fr. non Pers. = *Leocarpus fragilis* acc. to Lister

*D. rufipes* (Alb. & Schw.) Fr.

*D. rugulosum* Weinm.

*D. stipitatum* (Bull.) Fr.

*D. trichodes* (Lk.) Fr.—Not a Myxomycete

*Didymium alexandrowiczii* (Rost.) Mass. = *Diderma chondrioderma*

*D. candidum* Schrad.

*D. capitatum* Lk.

*D. comatum* List. = *D. difforme* var. *comatum*

*D. dædalium* Berk. & Rav.

*D. filamentosum* Wallr.

*D. flavidum* Pk.—An error; should be *Diderma*

*D. fulvipes* Fr.

*D. globosum* (Pers.) Chev.

*D. guarapiense* Speg.—An error; should be *D. paraguayense*

*D. hemisphaericum* (Bull.) Fr.

*D. humile* Hazzl.

*D. linkii* Fr.

*D. liquidum* Payer

*D. lobatum* Nees

*D. longipes* Mass.

*D. luteo-griseum* Berk. & Curt.

*D. megalosporum* Berk. & Curt.

*D. microcephalum* Chev. = *D. nigripes*

*D. muscicola* Lk.

*D. nanum* Fr.

*D. ossiculum* Pat. & Gaill.

*D. parietinum* Schrad.—Not a Myxomycete

*D. platense* Speg.

*Didymium platypus* Hazsl.

- D. plicatum* Corda
- D. præcox* de B. = *D. squamulosum*
- D. pruinosum* Berk. & Curt.
- D. ramosum* (Gmel.) Duby—Probably not a Myxomycete
- D. reticulatum* Berk. & Br. 1876, non Rost. 1873 = *Badhamia nitens* var. *reticulata*
- D. sinuosum* (Bull.) Dur. & Mont. = *Physarum bivalve*
- D. sowerbeii* Berk.
- D. terrestre* Fr.
- D. trichodes* Lk.—Not a Myxomycete
- D. versipelle* Fr.
- D. wallrothii* Rabenh.
- D. weinmanni* Fr.

*Enerthenema muscorum* Lév.*Enteridium antarcticum* Speg.

- E. simulans* Rost. = *E. olivaceum*

*Fuligo carnosa* Duby

- F. cerea* Sow.
- F. hortensis* Duby = *F. septica*
- F. ovata* (Schæff.) Macbr. = *F. septica*

*Hemiarcyria bucknalli* Mass.

- H. calyculata* Speg.
- H. chrysospora* List. = *Hemitrichia chrysospora*
- H. pusilla* Speg.
- H. varneyi* Rex

*Hemitrichia contorta* Rost.*Lachnobolus arcirella* Rost.*Lamproderma hookeri* (Berk.) Rav.

- L. inconspicuum* Schroet.
- L. leucosporum* Rost.
- L. nigrescens* Rost.
- L. schimperi* Rost. = *L. columbinum*
- L. staszczii* Racib.
- L. subæneum* Mass. = *L. arcyrionema*
- L. tatricum* Racib.

*Leocarpus calcareus* Lk.

- L. granulatus* (Schum.) Fr.
- L. melaleucus* Mont. = *Ph. bivalve*
- L. minutus* (Schum.) Fr.
- L. nitens* Fr.

*Lepidoderma kurzii* Berk.

- L. obovatum* Mass.
- L. payerimhoffii* Maire & Pinoy = *Diderma trevelyani* var. *nivale*
- L. reticulatum* Mass. = *Badhamia nitens* var. *reticulata*

*Licea artocreas* Berk. & Rav.

- L. badia* Fr.—Not a Myxomycete
- L. berteriana* Mont.—Not a Myxomycete
- L. bicolor* Pers.—Not a Myxomycete
- L. brassica* Skvortz.
- L. brunnea* Preuss
- L. epiphylla* Schw.
- L. fallax* Fr.
- L. glomulifera* de B. & Rost.
- L. incarnata* Alb. & Schw.
- L. inquinans* Spreng.
- L. macrospora* Schum.
- L. mandshurica* Skvortz.
- L. nitens* Schw.
- L. pannorum* Wallr.—Not a Myxomycete
- L. physaroides* Lk.
- L. quercina* Wallr.
- L. schænleinii* Johow
- L. serpula* Fr.
- L. spadicea* Fr.
- L. spumarioidea* Cke. & Mass.—Not a Myxomycete
- L. strobilina* Alb. & Schw.—Not a Myxomycete
- L. suberea* (Chev.) Fr.—Not a Myxomycete
- L. sulphurea* Wallr.—Not a Myxomycete
- L. tenuissima* Berk. & Br. = *Dictydæthallium plumbeum*

*Lindbladia versicolor* Rost.*Lycogala cinerea* Schum.

- L. globosum* Schrank—Not a Myxomycete
- L. incarnatum* Swartz
- L. niveum* Hoffm.—An immature *Lamproderma*
- L. ochraceum* Mass.—Not a Myxomycete
- L. parietinum* (Schrad.) Fr.—Not a Myxomycete
- L. platense* Speg.
- L. rostafinskii* Siemasz.
- L. rufo-cinnamomeum* Mass.—Not a Myxomycete
- L. torrendii* Bres.—Not a Myxomycete

*Nassula globosa* (Schw.) Fr. = *Lachnobolus globosus*

*Oligonema æneum* Karst.

*Ophiotheca anomala* (Karst.) Mass.

*Ophiuridium dissiliens* Hazsl.

*Perichæna annulifera* Boud.

*P. canoflavescens* Raunk.

*P. circumscissa* (Wallr.) Dalla T. & Samth.

*P. confusa* Mass. = *P. vermicularis*

*P. cornuroides* Čel. fil.

*P. decipiens* Berk. & Br.—Not a Myxomycete

*P. gregata* Fautr. & Lamb.

*P. incarnata* (Alb. & Schw.) Fr.

*P. krupii* Racib.

*P. microcarpa* Sauter

*P. nitens* Raunk.

*P. ochrospora* Pk.

*P. pallida* (Ces.) Berl.

*P. phæosperma* Karst.

*P. picea* Berk. & Br.—Not a Myxomycete

*P. plasmodiocarpa* Blytt = *Margarita metallica* var. *plasmodiocarpa*

*P. pseudacidium* Speg.

*P. strobilina* (Alb. & Schw.) Fr.

*P. vaporaria* Schw.

*Phelonites minima* Fr. = *Licea minima*

*P. strobilina* (Alb. & Schw.) Fr.—Not a Myxomycete

*Physarum alatum* (Trentep.) Fr.

*P. albipes* de B.

*P. albo-punctatum* Schum. = *P. nutans*

*P. alutaceum* Wallr.

*P. anceps* de B.

*P. antiades* (Bull.) Fr.

*P. asiaticum* Skvortz.

*P. aurantiacum* Alb. & Schw.

*P. braunianum* de B. ex Rost.

*P. brevipes* Schum.

*P. bryophilum* Fr.

*P. bulbiforme* Schum. = *P. nutans*

*P. cancellatum* Wallr.

*P. capense* Rost.

*P. chlorinum* Cke.

*P. cinerascens* Schum.

*P. delicatissimum* Speg.

*P. didymium* Schum.

*P. elegans* Schw.

*P. elongatum* Lk.

*P. fasciculatum* Jungh.

*P. fimetarium* Schum.

*Physarum flavidum* (Pk.) Berl. = *P. contextum*

*P. flavovirens* Alb. & Schw.

*P. fulgens* Pat.

*P. fulvipes* Fr.

*P. furfuraceum* Schum. = *P. nutans*

*P. globosum* Schum.

*P. gravidum* Morg. = *P. pusillum*

*P. hypnophilum* Fr.

*P. hypnorum* Lk.

*P. lepidodermoides* Blytt = *P. sulphureum*

*P. leucostictum* Chev.

*P. luteolum* Pk. = *P. virescens* var. *nitens*

*P. luteo-valve* Schw.

*P. mandshuricum* Skvortz.

*P. marginatum* Schum.

*P. melaleucum* Nyl.

*P. melanopus* Fr.

*P. mucoroides* Schillb.

*P. nigrum* Fr.

*P. oblongum* Fr.—An error; should be *Diderma*

*P. ochroleucum* Berk. & Curt.—An error; should be *Diderma*

*P. ornatum* Pk.

*P. oxyacanthæ* Schum.

*P. physaroides* Alb. & Schw.—An error; should be *Stemonitis*

*P. piceum* Fr.

*P. pini* Schum.

*P. platense* Speg.

*P. polonicum* Skup.

*P. polyædron* Schw.—Not a Myxomycete

*P. purpurascens* Lk.

*P. pyriforme* Schum.

*P. ramentaceum* Fr.

*P. rubropunctatum* Pat.

*P. salicinum* Schum.

*P. schræteri* Rost.

*P. solutum* Schum.

*P. sphaeroidale* Chev.

*P. stipitatum* (Bull.) Chev.

*P. subtile* Rost.

*P. subulatum* Schum.

*P. sulcatum* Lk.

*P. tucumanense* Speg.

*P. villosum* Schum.

*P. violaceum* Schum.

- Reticularia affinis* Berk. & Curt.—Not a Myxomycete  
*R. angulata* Pers.  
*R. apiospora* Berk. & Br.  
*R. applanata* Schw.  
*R. atro-rufa* Berk. & Curt.—Not a Myxomycete  
*R. cæsia* Gmel.  
*R. cinerea* Gmel.  
*R. complanata* Gmel.  
*R. epixylon* Bull.—Not a Myxomycete  
*R. fuliginosa* Berk. & Br.  
*R. lycogala* (Bolt.) Gmel.  
*R. multicapsula* Sow.  
*R. nigra* Bull.  
*R. nitens* Morg.  
*R. polyporiformis* Berk.—Not a Myxomycete  
*R. pyrrophospora* Berk. & Curt.—Not a Myxomycete  
*R. ramosa* Gmel.  
*R. segetum* Bull.—Not a Myxomycete  
*R. sphæroidalis* Bull.  
*R. stipitata* Bull.  
*R. testacea* Wallr.  
*R. unguilina* Fr.  
*R. ustilago* Bull.  
*R. utricularis* Gmel.  
*R. venulosa* Berk. & Curt.
- Stemonitis alba* Schrank  
*S. antiades* Gmel.  
*S. bombycina* Gmel.  
*S. carnea* Schrank  
*S. cinnabarina* Roth  
*S. cyathiformis* Schrank  
*S. decipiens* T. Nees  
*S. denudata* (L.) Relh. = *Arcyria denudata*  
*S. elongata* Willd.  
*S. ficoides* Gmel.  
*S. filicina* Schrank  
*S. flava* Gmel.  
*S. flavescens* Schrank  
*S. fluminensis* Speg.  
*S. fulva* Gmel.  
*S. furfuracea* Gmel.  
*S. globosa* Trentep.  
*S. globularis* Gmel.  
*S. graniformis* Gmel.  
*S. heterospora* Oudem.  
*S. leucopus* Gmel.
- Stemonitis lichenoides* Gmel.  
*S. lilacina* Schrank  
*S. mammosa* Fr.  
*S. morthieri* Fuck.  
*S. nivea* (Hoffm.) Gmel.  
*S. obtusata* Fr. = *Comatricha nigra*  
*S. olivacea* Gmel.  
*S. protracta* Fr.  
*S. pumila* Fr.  
*S. purpurea* Schrank  
*S. pyriformis* Willd.  
*S. recucita* Gmel.  
*S. reticulata* Trentep.  
*S. semitrichioides* Gmel.  
*S. sphærocarpa* Schrank  
*S. sphærocephala* Sob.  
*S. subclavata* Zoll.  
*S. sulphurea* Roth—Not a Myxomycete  
*S. trichia* Roth  
*S. turbinata* Gmel.  
*S. vesiculosa* Gmel.  
*S. violacea* Roth  
*S. vitellina* Gmel.
- Trichia alata* Trentep.  
*T. alba* Sow.  
*T. angulata* Schw.  
*T. anomala* Karst.  
*T. antiades* (Bull.) DC.  
*T. applanata* Hedw.  
*T. arcyræformis* Schum.  
*T. aurea-affinis* "Fl. Dan."  
*T. badia* Fr.  
*T. citrina* Schum.  
*T. coccinea* Hoffm.  
*T. crassa* Schum.  
*T. difforme* Schw.  
*T. erythropus* Borsz.  
*T. expansa* Mont.  
*T. faginea* Johnst.—Not a Myxomycete  
*T. fulva* With.  
*T. furcata* Wigand  
*T. furfuracea* With.  
*T. globosa* Vill. = *Didymium melanospermum*  
*T. hemispherica* Trentep.  
*T. lenticularis* Hoffm.—Not a Myxomycete  
*T. lichenoides* Sibth.  
*T. meteorica* Sow.



*Trichia miniata* Schw.*T. minima* Mass.*T. minuta* (Leers) Relh. = *Craterium minutum**T. muscicola* Poir.*T. nivea* Hoffm.—Not a Myxomycete*T. notata* Schum. = *Enerthenema papillatum**T. obtusa* Wigand*T. ovalispora* Hollós*T. physaroides* Schum. = *Lamproderma physaroides**T. polymorpha* Sow.*T. punctulata* Schw.*Trichia purpurea* Schum.*T. radiata* Vill.*T. ramulosa* Rudol.—Not a Myxomycete*T. recutita* With.*T. rugosa* Trentep.*T. semicancellata* DC.*T. spherica* Trentep.*T. sphaerocephala* Hoffm.—Not a Myxomycete*T. turbinata* With.*T. variabilis* Poir.*T. violacea* Hoffm.*T. viridis* DC.*T. vulgaris* Pers.

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## PLATES

The preparation of the plates is the work of Miss Gladys Baker. The habit sketches are nearly all hers and a number of her diagrams made from paraffin sections and originally published elsewhere, have been redrawn. Spores, capillitium and other microscopic structures were drawn in pencil, with the aid of a camera lucida, by the junior author, the spores always and the other structures frequently under an apochromatic oil immersion lens. It is hoped that the reproduction of the spore drawings at a uniform magnification of 1200 diameters will facilitate comparison of these critical characters.

## EXPLANATION OF PLATE I

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*Ceratiomyxa fruticulosa* (Muell.) Macbr.

Figs. 1, 2, 3, 4, 5. Habit,  $\times 10$ ; spores,  $\times 1200$ ; var. *arbuscula*, habit,  $\times 10$ ; spores of var. *arbuscula*,  $\times 1200$ ; spores of var. *porioides*,  $\times 1200$ .

*Fuligo septica* (L.) Weber

Figs. 6, 7, 8. Diagrammatic section of a small æthelium,  $\times 5$ ; spore, with outline of two others to show variation in size,  $\times 1200$ ; var. *violacea*, spores,  $\times 1200$ .

*Fuligo muscorum* Alb. & Schw.

Figs. 9, 10. Diagrammatic section of æthelium,  $\times 5$ ; spore,  $\times 1200$ .

*Fuligo cinerea* (Schw.) Morg.

Fig. 11. Spores,  $\times 1200$ .

*Fuligo intermedia* Macbr.

Fig. 12. Spore,  $\times 1200$ .

*Fuligo megaspora* Sturgis

Fig. 13. Spore,  $\times 1200$ .

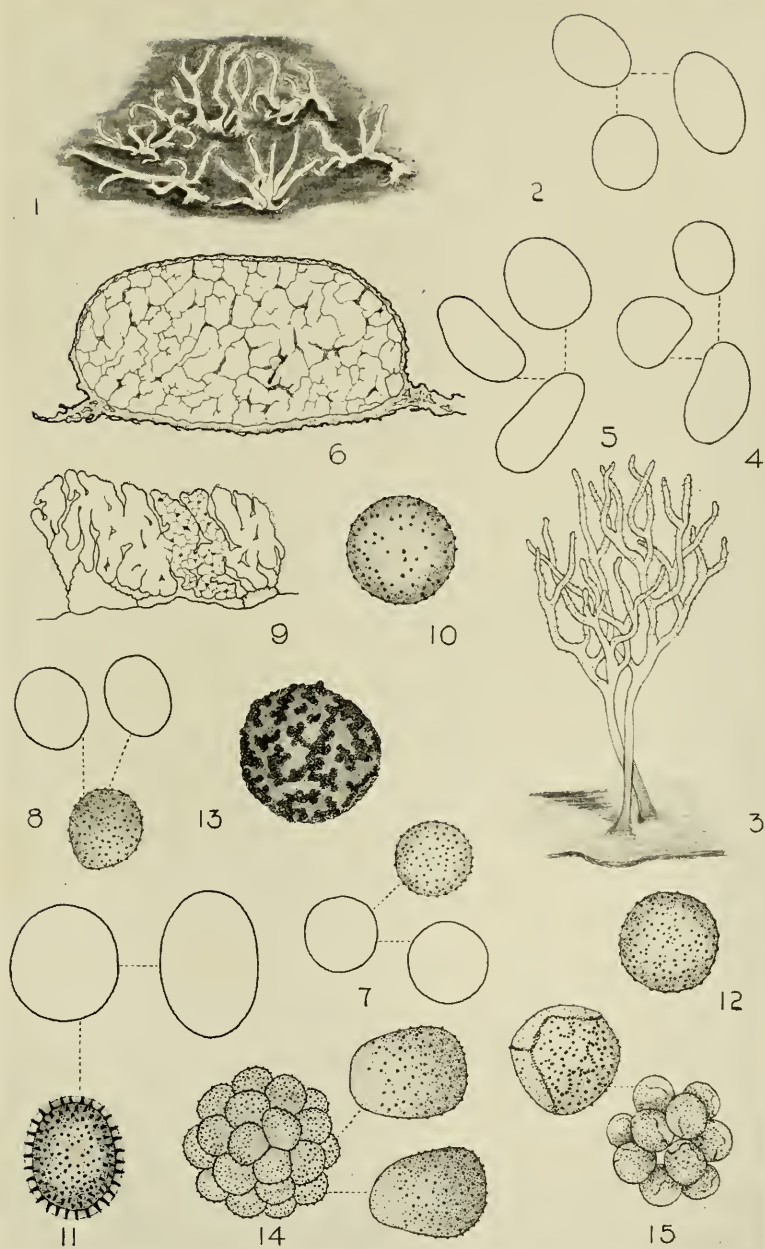
*Badhamia versicolor* List.

Fig. 14. Two isolated spores,  $\times 1200$ ; spore cluster,  $\times 550$ .

*Badhamia populina* List.

Fig. 15. Isolated spore,  $\times 1200$ ; spore cluster,  $\times 550$ .

# PLATE I





## EXPLANATION OF PLATE II

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*Bodhamia nitens* Berk.

Figs. 16, 17. Habit,  $\times 10$ ; isolated spores,  $\times 1200$ ; spore cluster,  $\times 550$ .

*Badhamia papaveracea* Berk. & Rav.

Figs. 18, 19. Habit,  $\times 10$ ; single spore,  $\times 1200$ ; spore cluster,  $\times 550$ .

*Badhamia capsulifera* (Bull.) Berk.

Figs. 20, 21. Habit,  $\times 10$ ; isolated spore,  $\times 1200$ ; spore cluster,  $\times 550$ .

*Badhamia ulricularis* (Bull.) Berk.

Figs. 22, 23. Habit,  $\times 10$ ; spore,  $\times 1200$ ; cluster of spores,  $\times 550$ .

*Badhamia magna* Peck

Figs. 24, 25, 26. Habit,  $\times 10$ ; spore of usual spherical type,  $\times 1200$ ; spore from Peck's type,  $\times 1200$ .

*Badhamia decipiens* (Curt.) Berk.

Figs. 27, 28. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Badhamia orbiculata* Rex

Figs. 29, 30. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Badhamia macrocarpa* (Ces.) Rost.

Figs. 31, 32. Habit,  $\times 10$ ; spore,  $\times 1200$ .

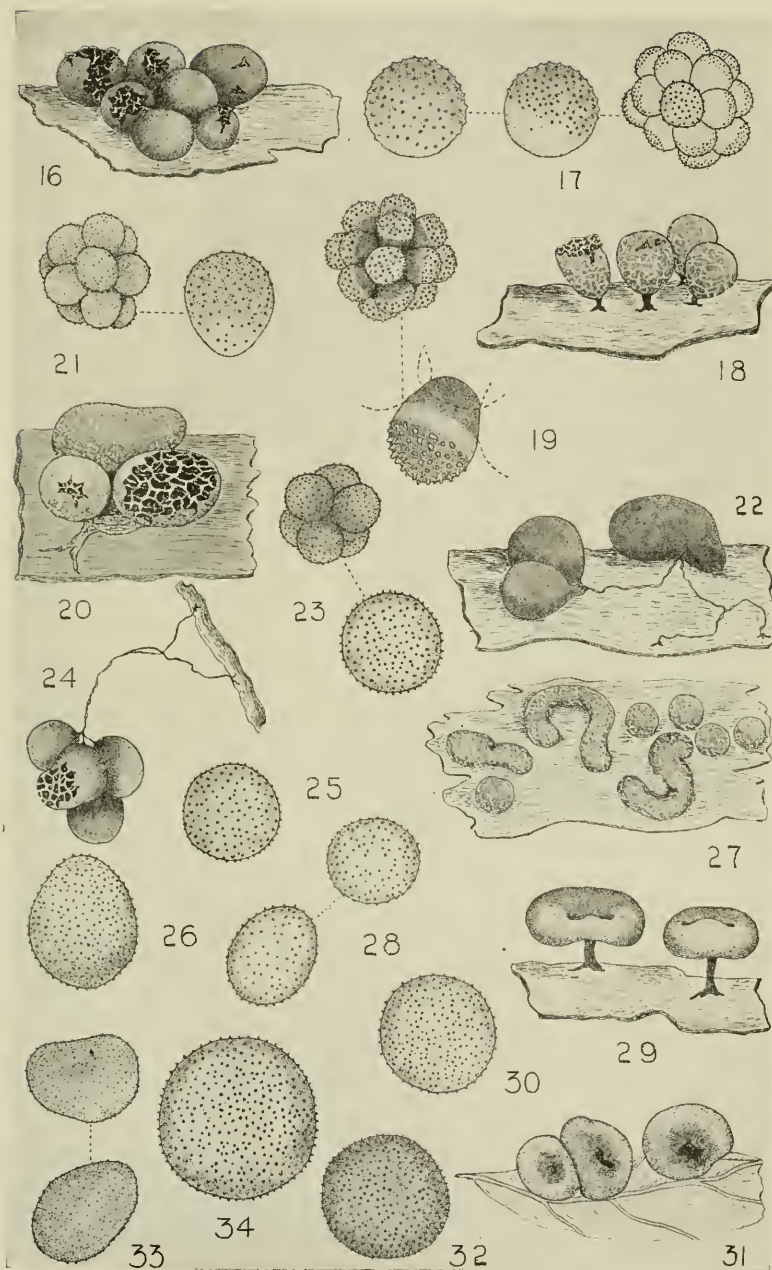
*Badhamia ovispora* Racib.

Fig. 33. Spores,  $\times 1200$ .

*Badhamia affinis* Rost.

Fig. 34. Spore,  $\times 1200$ .

# PLATE II



### EXPLANATION OF PLATE III

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*Badhamia panicea* (Fr.) Rost.

Figs. 35, 36. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Badhamia gracilis* Macbr.

Figs. 37, 38. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Badhamia lilacina* (Fr.) Rost.

Figs. 39, 40. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Badhamia rubiginosa* (Chev.) Rost.

Figs. 41, 42, 43. Habit,  $\times 10$ ; section of a sporangium,  $\times 50$ ; spore,  $\times 1200$ .

*Badhamia cinerascens* Martin

Fig. 44. Spores,  $\times 1200$ .

*Physarum cinereum* (Batsch) Pers.

Figs. 45, 46. Habit,  $\times 10$ ; spore,  $\times 1200$ .

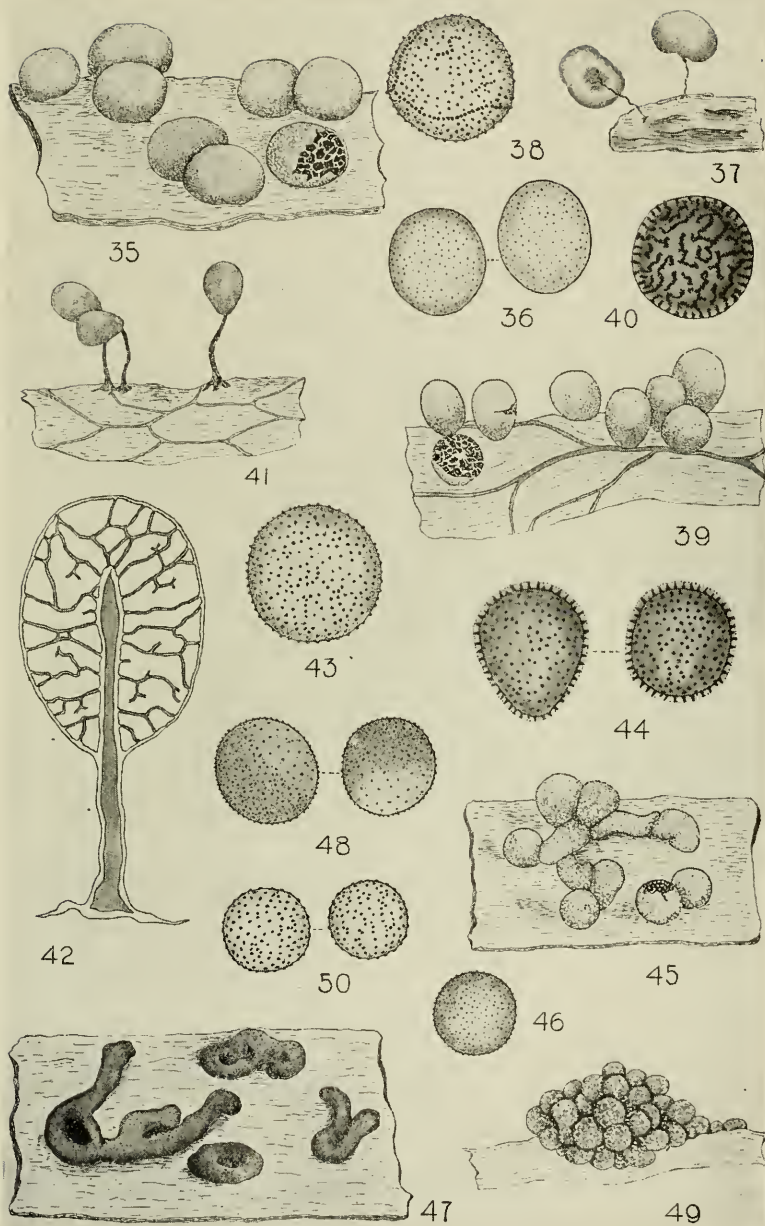
*Physarum serpula* Morg.

Figs. 47, 48. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Physarum virescens* Ditm.

Figs. 49, 50. Habit,  $\times 10$ ; spores,  $\times 1200$ .

# PLATE III





## EXPLANATION OF PLATE IV

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*Physarum rubiginosum* Fr.

Figs. 51, 52. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Physarum digitatum* Farquh. & G. List.

Figs. 53, 54. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum bilectum* List.

Figs. 55, 56. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum bivalve* Pers.

Figs. 57, 58, 59. Habit,  $\times 10$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum diderma* Rost.

Figs. 60, 61. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum alpinum* G. List.

Figs. 62, 63. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum galbeum* Wing.

Fig. 64. Spore,  $\times 1200$ .

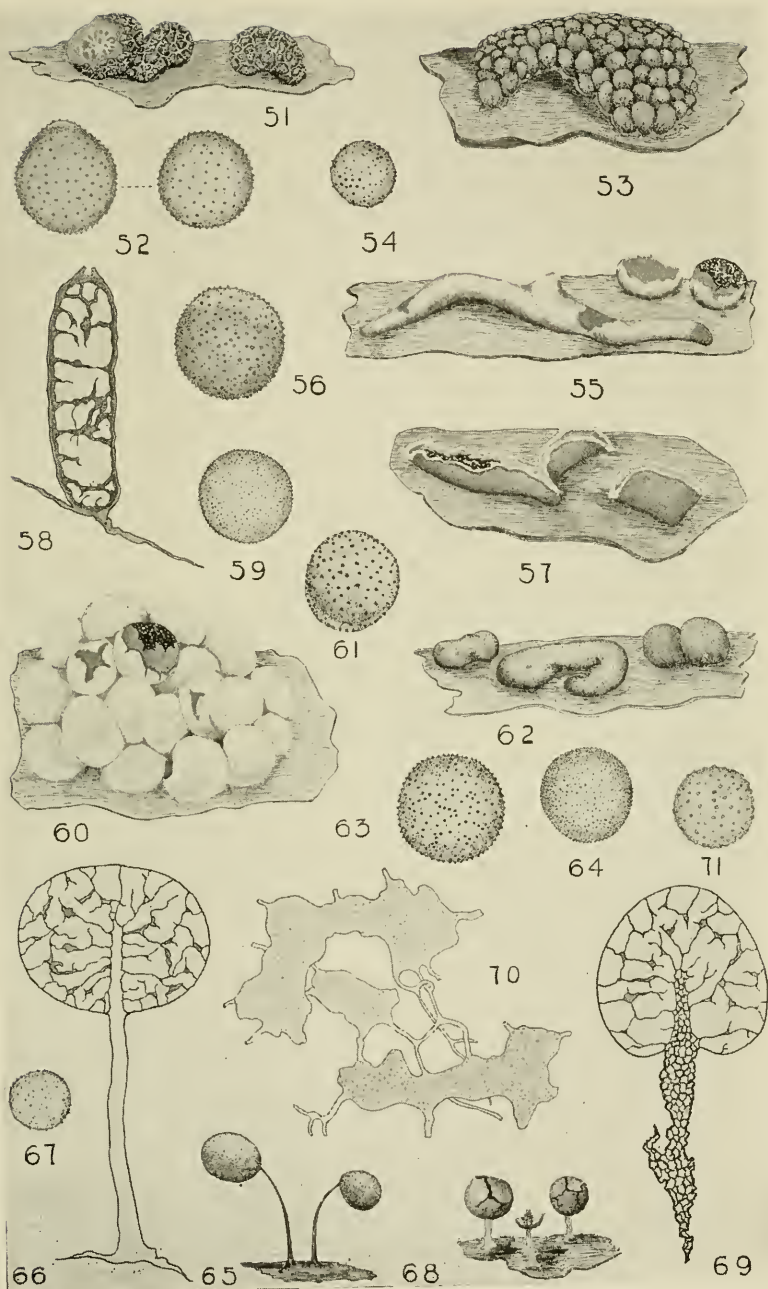
*Physarum penetrale* Rex

Figs. 65, 66, 67. Habit,  $\times 12$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum melleum* (Berk. & Br.) Massee

Figs. 68, 69, 70, 71. Habit,  $\times 10$ ; section of a sporangium,  $\times 24$ ; capillitium,  $\times 250$ ; spore,  $\times 1200$ .

# PLATE IV



## EXPLANATION OF PLATE V

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*Physarum mortoni* Macbr.

Figs. 72, 73. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum albo-luteum* Macbr. & Mart.

Figs. 74, 75. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum globuliferum* (Bull.) Pers.

Figs. 76, 77, 78. Habit,  $\times 10$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum murinum* List.

Figs. 79, 80. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum pulcherripes* Peck

Figs. 81, 82. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum pulcherrimum* Berk. & Rav.

Figs. 83, 84. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum nudcatum* Rex

Figs. 85, 86, 87. Habit,  $\times 10$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum didermoides* (Ach.) Rost.

Figs. 88, 89, 90. Habit,  $\times 10$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum wingatense* Macbr.

Figs. 91, 92. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum compressum* Alb. & Schw.

Figs. 93, 94, 95. Spore,  $\times 1200$ ; section of a sporangium,  $\times 30$ ; habit,  $\times 10$ .

*Physarum psittacinum* Ditm.

Figs. 96, 97. Habit,  $\times 10$ ; spore,  $\times 1200$ .

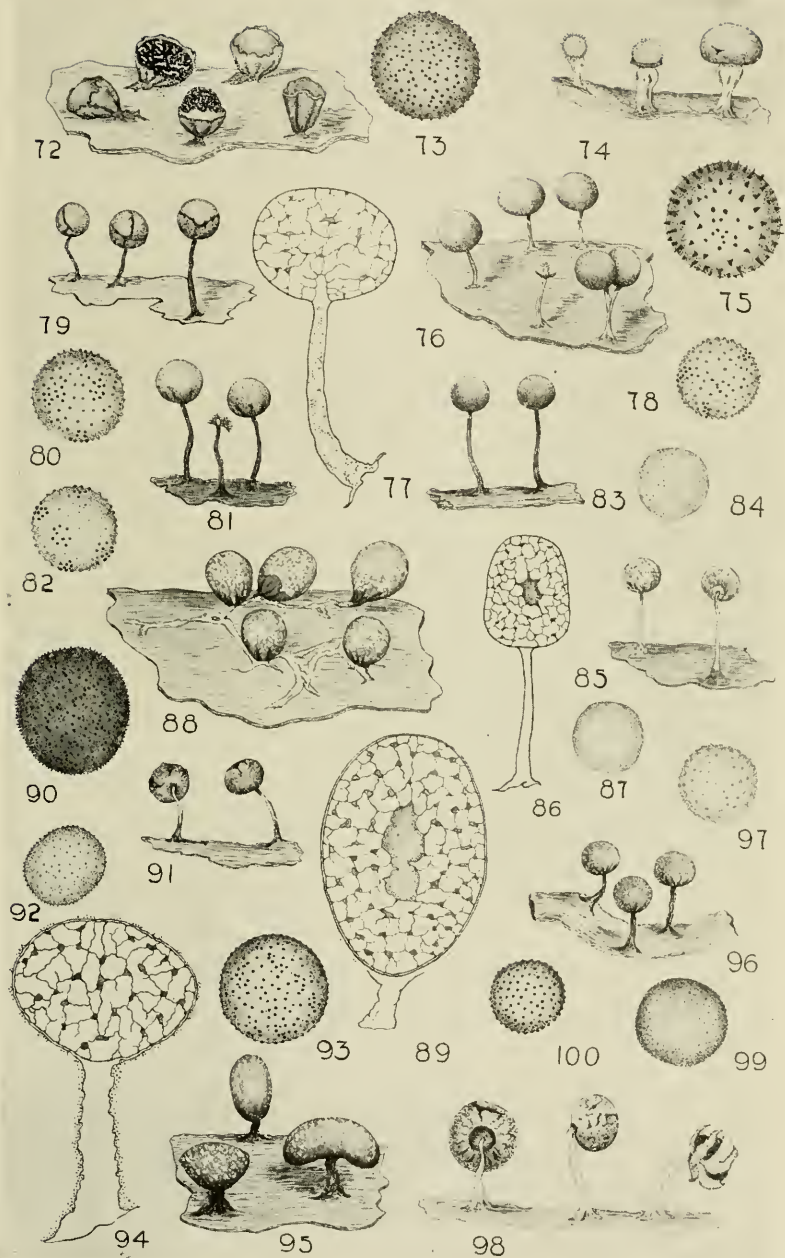
*Physarum leucophæum* Fr.

Figs. 98, 99. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum leucopus* Link

Fig. 100. Spore,  $\times 1200$ .

# PLATE V



## EXPLANATION OF PLATE VI

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*Physarum contextum* Pers.

Figs. 101, 102. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum notabile* Macbr.

Figs. 103, 104. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum pusillum* (Berk. & Curt.) List.

Figs. 105, 106. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum albescens* Ellis

Figs. 107, 108. Habit of sessile form,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum citrinellum* Peck

Figs. 109, 110. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum flavicomum* Berk.

Figs. 111, 112, 113. Habit,  $\times 10$ ; section of a sporangium,  $\times 30$ ; spore,  $\times 1200$ .

*Physarum sulphureum* Alb. & Schw.

Figs. 114, 115. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Physarum auriscalpium* Cooke

Figs. 116, 117. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum tenerum* Rex

Figs. 118, 119. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum oblatum* Macbr.

Figs. 120, 121. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum polycephalum* Schw.

Fig. 122. Habit,  $\times 10$ .

*Physarum gyrosum* Rost.

Figs. 123, 124. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Physarum nutans* Pers.

Figs. 125, 126. Habit,  $\times 10$ ; Spore,  $\times 1200$ .

*Physarum viride* (Bull.) Pers.

Figs. 127, 128. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Craterium paraguayense* (Speg.) List.

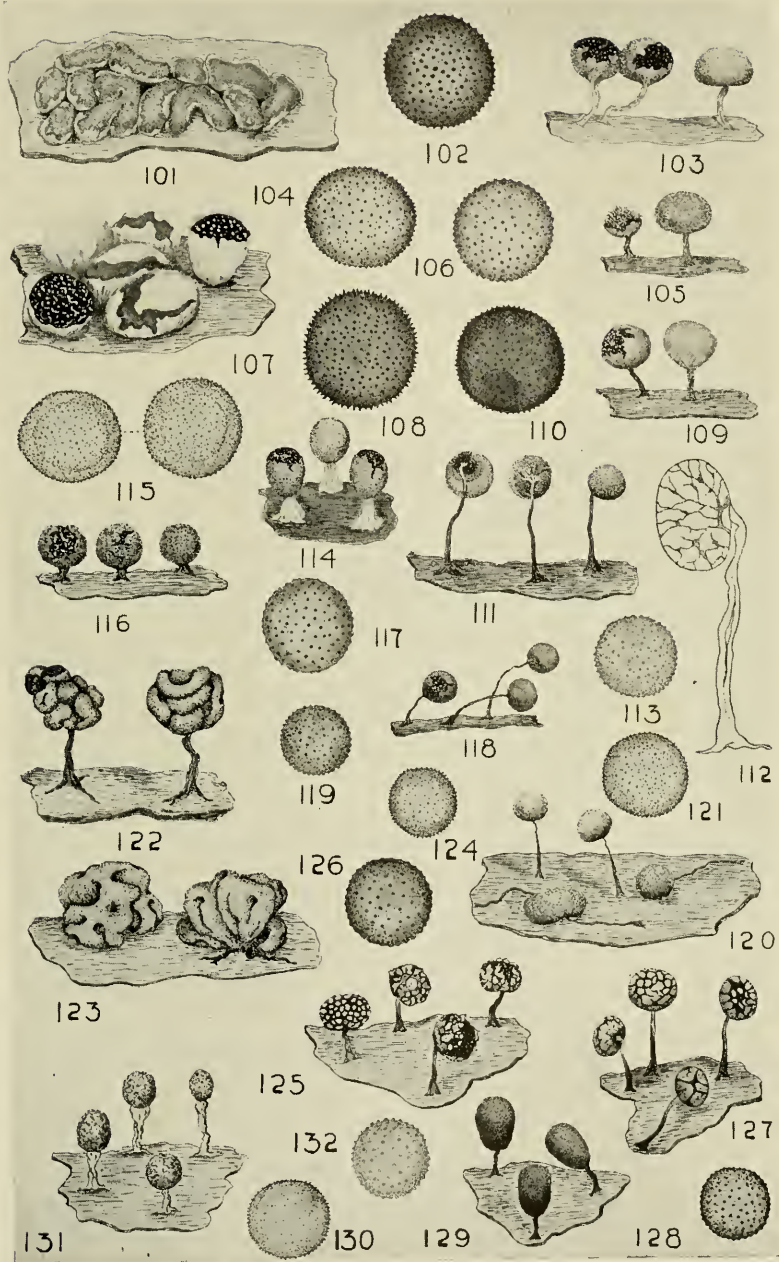
Figs. 129, 130. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Craterium aureum* (Schum.) Rost.

Figs. 131, 132. Habit,  $\times 10$ ; spore,  $\times 1200$ .



# PLATE VI



## EXPLANATION OF PLATE VII

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*Cratcrium leucocephalum* (Pers.) Ditm.

Figs. 133, 134, 135. Habit,  $\times 10$ ; section of a sporangium,  $\times 40$ ; spore,  $\times 1200$ .

*Cratcrium cylindricum* Massee

Figs. 136, 137. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Craterium minutum* (Leers) Fr.

Figs. 138, 139, 140. Habit,  $\times 10$ ; section of a sporangium,  $\times 40$ ; spore,  $\times 1200$ .

*Trichamphora pezizoides* Jungh.

Figs. 141, 142. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Cienkowskia reticulata* (Alb. & Schw.) Rost.

Figs. 143, 144, 145. Habit,  $\times 10$ ; capillitium,  $\times 550$ ; spore,  $\times 1200$ .

*Leocarpus fragilis* (Dicks.) Rost.

Figs. 146, 147, 148. Habit,  $\times 10$ ; portion of wall with dual capillitium attached,  $\times 30$ ; spore,  $\times 1200$ .

*Mucilago spongiosa* (Leyss.) Morg.

Figs. 149, 150. Section of an æthelium,  $\times 2$ ; spore,  $\times 1200$ .

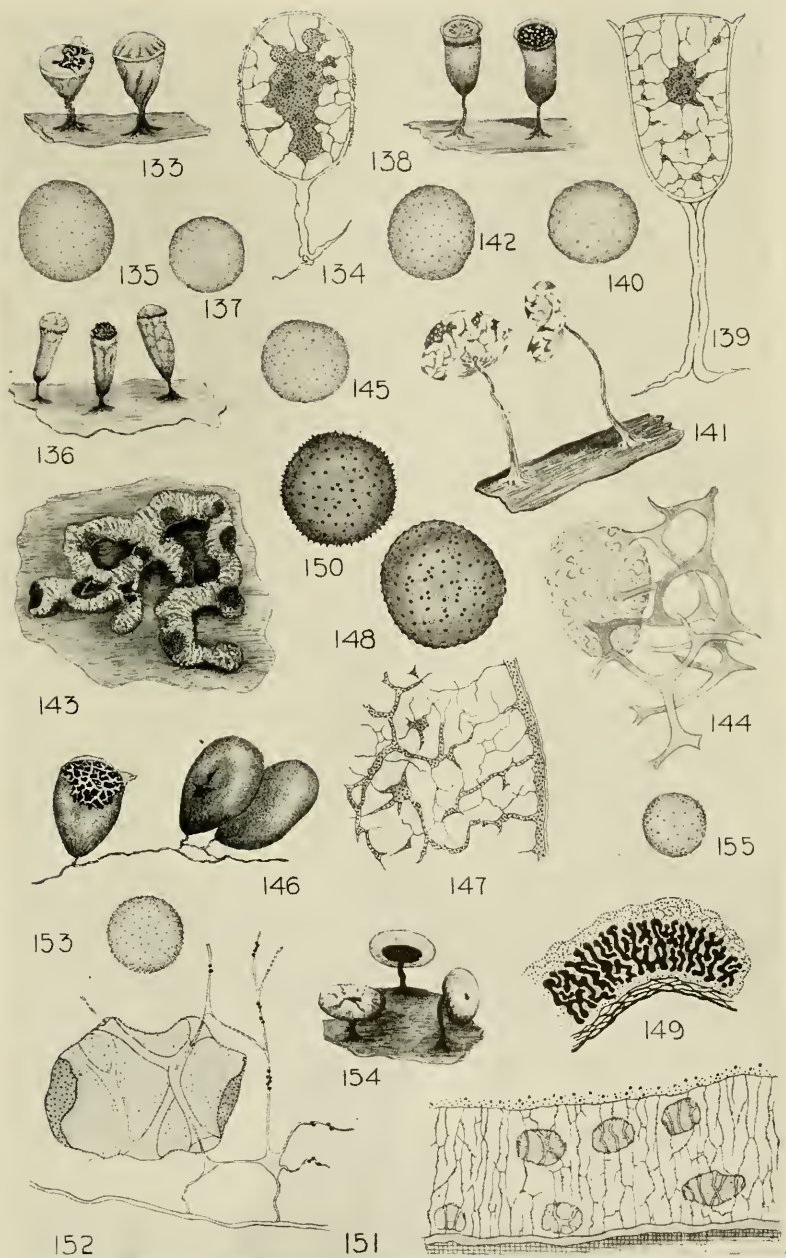
*Didymium camplanatum* (Batsch) Rost.

Figs. 151, 152, 153. Section of a plasmodiocarp,  $\times 130$ ; detail of vesicle and capillitium,  $\times 525$ ; spore,  $\times 1200$ .

*Didymium clavus* (Alb. & Schw.) Rabenh.

Figs. 154, 155. Habit,  $\times 10$ ; spore,  $\times 1200$ .

# PLATE VII



## EXPLANATION OF PLATE VIII

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*Didymium anellus* Morg.

Figs. 156, 157, 158. Habit,  $\times 10$ ; spore,  $\times 1200$ ; crystal,  $\times 1200$ .

*Didymium squamulosum* (Alb. & Schw.) Fr.

Figs. 159, 160, 161, 162, 163. Habit,  $\times 20$ ; section of a sporangium,  $\times 15$ ; spore,  $\times 1200$ ; spores of var. *claviforme*,  $\times 1200$ ; crystal of var. *claviforme*,  $\times 1200$ .

*Didymium melanospermum* (Pers.) Macbr.

Figs. 164, 165. Habit,  $\times 20$ ; spore,  $\times 1200$ .

*Didymium minus* Morg.

Figs. 166, 167. Habit,  $\times 20$ ; spore,  $\times 1200$ .

*Didymium nigripes* (Link) Fr.

Figs. 168, 169. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Didymium xonthopus* (Ditm.) Fr.

Figs. 170, 171. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Didymium difforme* (Pers.) Duby

Figs. 172, 173. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Didymium quitense* (Pat.) Torr.

Fig. 174. Spore,  $\times 1200$ .

*Didymium fulvum* Sturgis

Fig. 175. Spore,  $\times 1200$ .

*Didymium crustaceum* Fr.

Fig. 176. Spore,  $\times 1200$ .

*Didymium niviculum* Meylan

Fig. 177. Spore,  $\times 1200$ .

*Diderma effusum* (Schw.) Morg.

Figs. 178, 179, 180, 181. Habit,  $\times 10$ ; spore,  $\times 1200$ ; var. *reticulatum*, habit,  $\times 10$ ; spore of var. *reticulatum*,  $\times 1200$ .

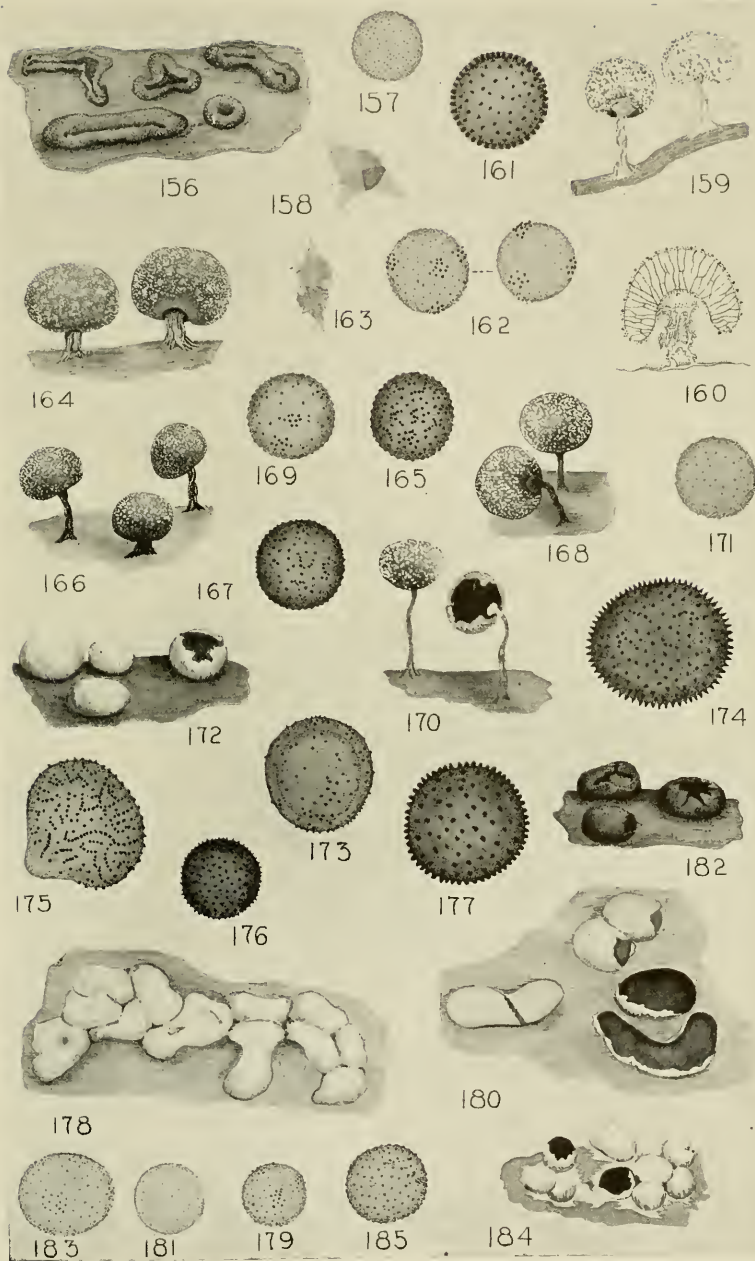
*Diderma simplex* (Schroet.) List.

Figs. 182, 183. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Diderma spumarioides* Fr.

Figs. 184, 185. Habit,  $\times 10$ ; spore,  $\times 1200$ .

# PLATE VIII





## EXPLANATION OF PLATE IX

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- Diderma crustaceum* Peck  
Figs. 186, 187. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma globosum* Pers.  
Figs. 188, 189. Habit,  $\times 15$ ; spore,  $\times 1200$ .
- Diderma lyallii* (Masse) Macbr.  
Figs. 190, 191. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma niveum* (Rost.) Macbr.  
Figs. 192, 193. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma testaceum* (Schrad.) Pers.  
Figs. 194, 195. Habit,  $\times 15$ ; spore,  $\times 1200$ .
- Diderma hemisphaericum* (Bull.) Hornem.  
Figs. 196, 197. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma montanum* Meylan  
Figs. 198, 199. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma trevelyani* (Grev.) Fr.  
Figs. 200, 201. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma asteroides* List.  
Figs. 202, 203. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma radiatum* (L.) Morg.  
Figs. 204, 205. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma roanense* (Rex) Macbr.  
Figs. 206, 207. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma floriforme* (Bull.) Pers.  
Figs. 208, 209. Habit,  $\times 10$ ; spore,  $\times 1200$ .
- Diderma rugosum* (Rex) Macbr.  
Figs. 210, 211. Habit,  $\times 10$ ; spore,  $\times 1200$ .

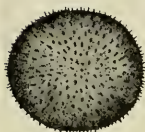
# PLATE IX



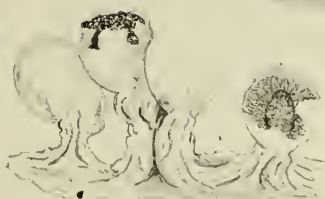
186



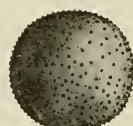
188



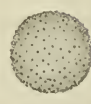
187



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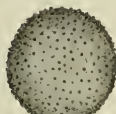
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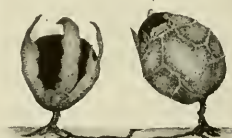
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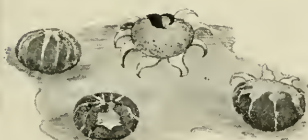
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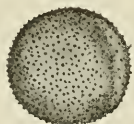
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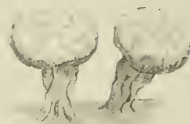
200



202



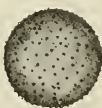
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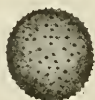
204



206



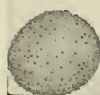
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205



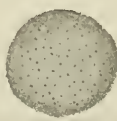
209



211



210



207



208

## EXPLANATION OF PLATE X

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*Lepidoderma tigrinum* (Schräd.) Rost.

Figs. 212, 213. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lepidoderma granuliferum* (Phill.) R. E. Fr.

Figs. 214, 215, 216. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Lepidoderma carestianum* Rost.

Figs. 217, 218, 219. Habit,  $\times 5$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Colloderma oculatum* (Lipp.) G. List.

Figs. 220, 221, 222. Section of a sporangium,  $\times 25$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Physarella oblonga* (Berk. & Curt.) Morg.

Figs. 223, 224, 225. Habit,  $\times 10$ ; section of a sporangium,  $\times 25$ ; spore,  $\times 1200$ .

*Diachea leucopodia* (Bull.) Rost.

Figs. 226, 227, 228. Habit,  $\times 15$ ; section of a sporangium,  $\times 25$ ; spore,  $\times 1200$ .

*Diachea splendens* Peck

Figs. 229, 230. Habit,  $\times 15$ ; spores,  $\times 1200$ .

*Diachea subsessilis* Peck

Figs. 231, 232. Habit,  $\times 20$ ; spore,  $\times 1200$ .

*Diachea thomasi* Rex

Figs. 233, 234. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Diachea bulbilosa* (Berk. & Br.) Lister

Fig. 235. Spores,  $\times 1200$ .

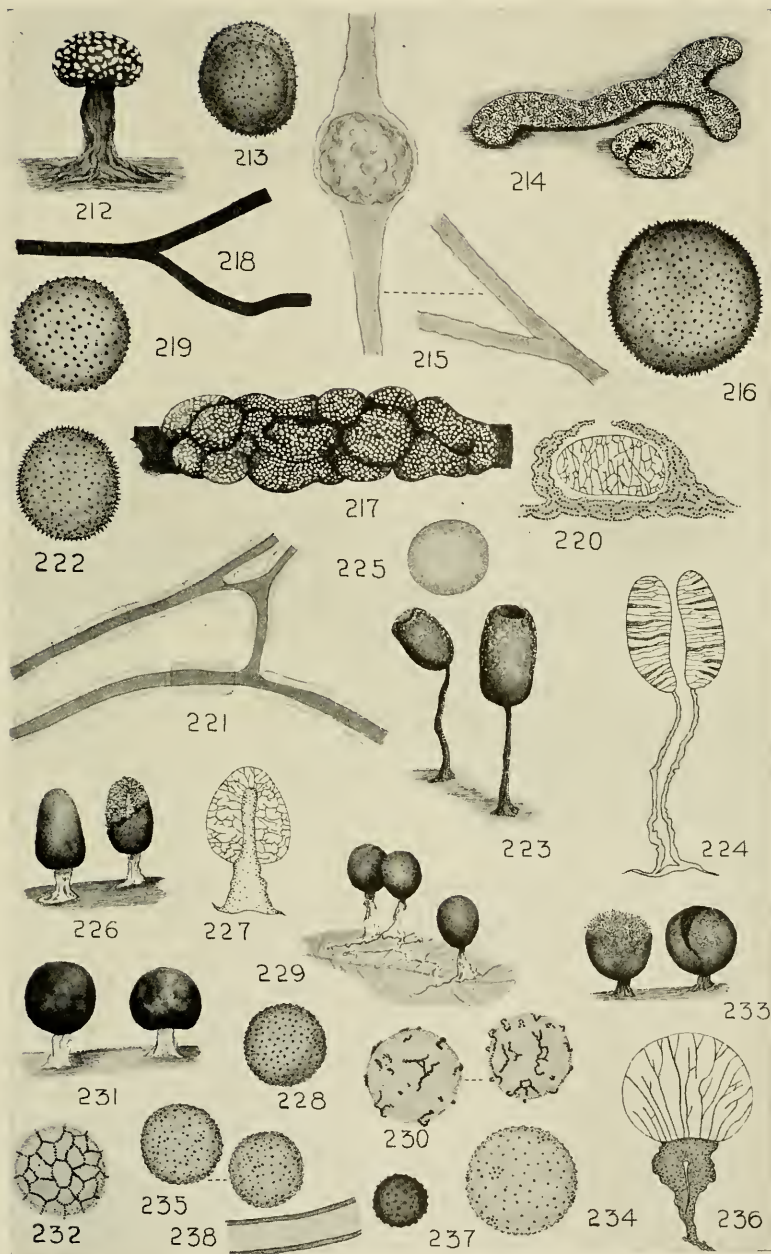
*Diachea cerifera* G. List.

Fig. 236. Section of a sporangium,  $\times 15$ .

*Schenella simplex* Macbr.

Figs. 237, 238. Spore,  $\times 1200$ ; capillitium,  $\times 1200$ .

# PLATE X



## EXPLANATION OF PLATE XI

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*Amaurochæte trechispora* Macbr. & Martin

Figs. 239, 240. Spores,  $\times 1200$ ; capillitium,  $\times 100$ .

*Amaurochæte ferruginea* Macbr. & Martin

Fig. 241. Spore,  $\times 1200$ .

*Amaurochæte fuliginosa* (Sow.) Macbr.

Fig. 242. Spore,  $\times 1200$ .

*Amaurochæte tubulina* (Alb. & Schw.) Macbr.

Fig. 243. Spore,  $\times 1200$ .

*Brefeldia maxima* (Fr.) Rost.

Figs. 244, 245. Vesicle and spore,  $\times 550$ ; spore,  $\times 1200$ .

*Stemonitis nigrescens* Rex

Fig. 246. Spore,  $\times 1200$ .

*Stemonitis dictyospora* Rost.

Figs. 247, 248. Habit,  $\times 1$ ; spore,  $\times 1200$ .

*Stemonitis fusca* Roth

Figs. 249, 250. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Stemonitis virginienensis* Rex

Figs. 251, 252. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Stemonitis hyperopta* Meylan

Figs. 253, 254. Habit,  $\times 5$ ; spores,  $\times 1200$ .

*Stemonitis confluens* Cooke & Ellis

Figs. 255, 256. Vesicle,  $\times 65$ ; spore,  $\times 1200$ .

*Stemonitis uvifera* Macbr.

Figs. 257, 258, 259. Habit,  $\times 5$ ; spores,  $\times 1200$ ; spores in a clump,  $\times 550$ .

*Stemonitis fenestrata* Macbr.

Figs. 260, 261. Habit,  $\times 4$ ; spore,  $\times 1200$ .

*Stemonitis splendens* Rost.

Figs. 262, 263. Habit,  $\times 3$ ; spore,  $\times 1200$ .

*Stemonitis webberi* Rex

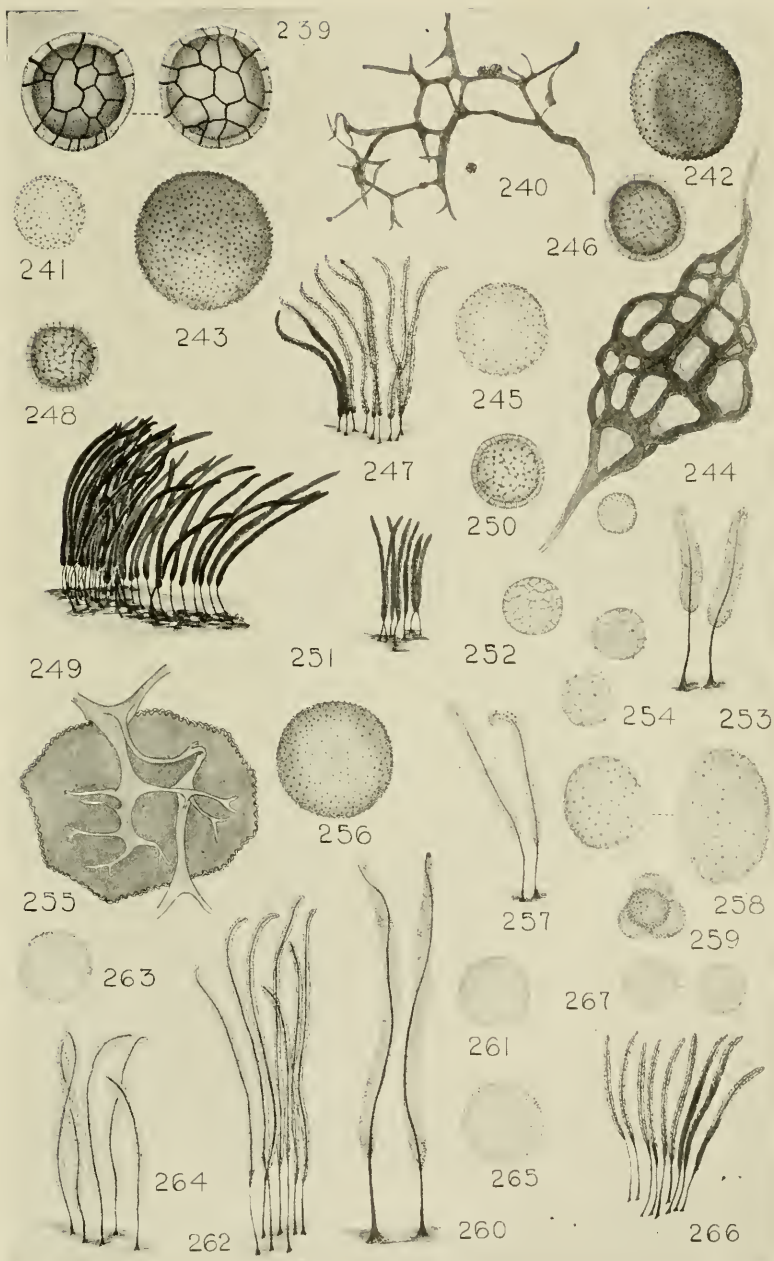
Figs. 264, 265. Habit,  $\times 2$ ; spore,  $\times 1200$ .

*Stemonitis axifera* (Bull.) Macbr.

Figs. 266, 267. Habit,  $\times 2$ ; spore,  $\times 1200$ .



# PLATE XI



## EXPLANATION OF PLATE XII

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*Stemonitis smithii* Macbr.

Figs. 268, 269. Habit,  $\times 5$ ; spores,  $\times 1200$ .

*Stemonitis flavogenita* Jahn

Figs. 270, 271. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Stemonitis carolinensis* Macbr.

Figs. 272, 273. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Stemonitis pallida* Wing.

Figs. 274, 275. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Stemonitis herbatica* Peck

Figs. 276, 277. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Comatricha cæspitosa* Sturgis

Figs. 278, 279. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha cylindrica* (Bilgr.) Macbr.

Figs. 280, 281. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha rispaudii* Hagelstein

Figs. 282, 283. Habit,  $\times 7$ ; spore,  $\times 1200$ .

*Comatricha flaccida* (List.) Morg.

Figs. 284, 285. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha irregularis* Rex

Figs. 286, 287. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha laxa* Rost.

Figs. 288, 289, 290. Habit,  $\times 15$ ; capillitium,  $\times 250$ ; spores,  $\times 1200$ .

*Comatricha suksdorfii* E. & E.

Figs. 291, 292. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha typhoides* (Bull.) Rost.

Figs. 293, 294. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Comatricha subcæspitosa* Peck

Figs. 295, 296. Habit,  $\times 10$ ; spore,  $\times 1200$ .

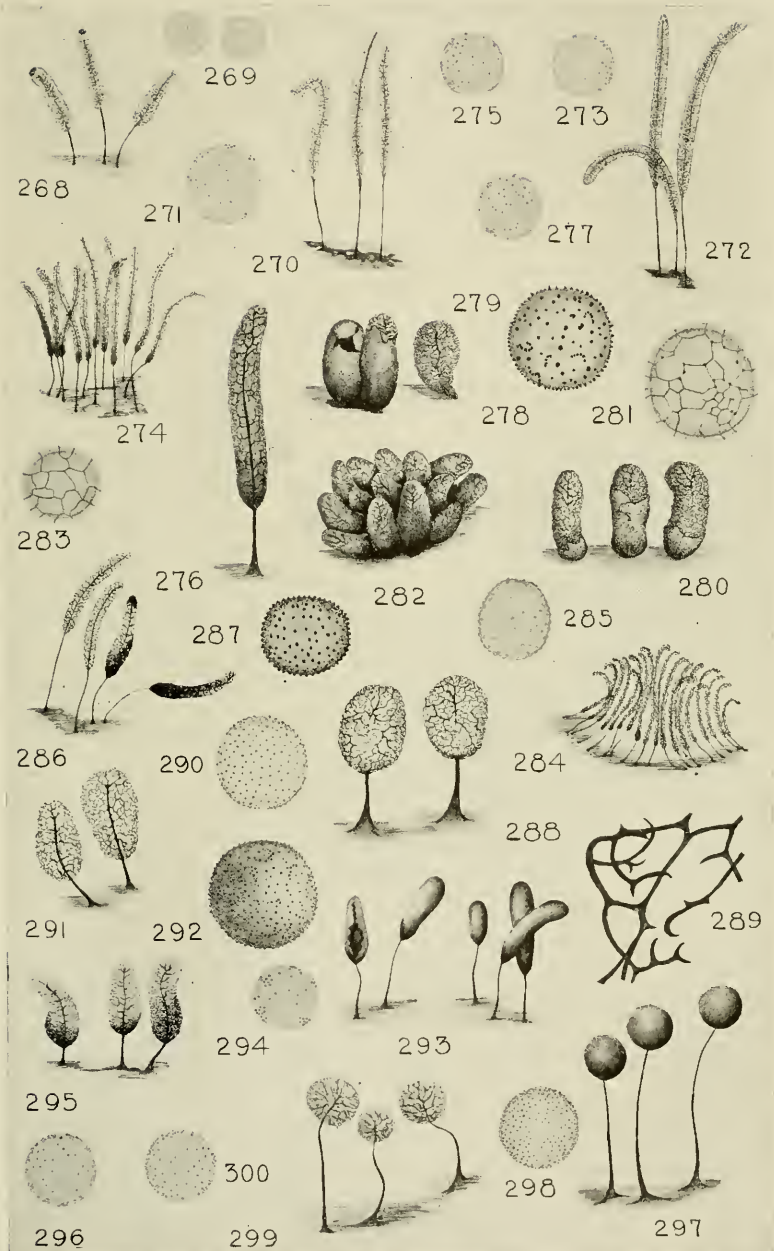
*Comatricha nigra* (Pers.) Schroet.

Figs. 297, 298. Habit,  $\times 7$ ; spore,  $\times 1200$ .

*Comatricha elegans* (Racib.) List.

Figs. 299, 300. Habit,  $\times 10$ ; spore,  $\times 1200$ .

# PLATE XII



## EXPLANATION OF PLATE XIII

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*Comatricha pulchella* (Bab.) Rost.

Figs. 301, 302. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Comatricha longa* Peck

Figs. 303, 304. Capillitium,  $\times 85$ ; spore,  $\times 1200$ .

*Euerthenema papillatum* (Pers.) Rost.

Figs. 305, 306. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Euerthenema melanospermum* Macbr. & Martin

Figs. 307, 308. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Lamproderma cribrarioides* (Fr.) R. E. Fr.

Figs. 309, 310. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma cristatum* Meylan

Fig. 311. Spores,  $\times 1200$ .

*Lamproderma atrosporum* Meylan

Figs. 312, 313. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma gulielmæ* Meylan

Figs. 314, 315. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma carestiae* (Ces. & de Not.) Meylan

Figs. 316, 317. Habit,  $\times 7$ ; spores,  $\times 1200$ .

*Lamproderma violaceum* (Fr.) Rost.

Figs. 318, 319. Habit,  $\times 12$ ; spore,  $\times 1200$ .

*Lamproderma saulcri* Rost.

Figs. 320, 321. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma arcyriouema* Rost.

Figs. 322, 323. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma scintillans* (Berk. & Br.) Morg.

Figs. 324, 325. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lamproderma columbinum* (Pers.) Rost.

Figs. 326, 327. Habit,  $\times 10$ ; spore,  $\times 1200$ .

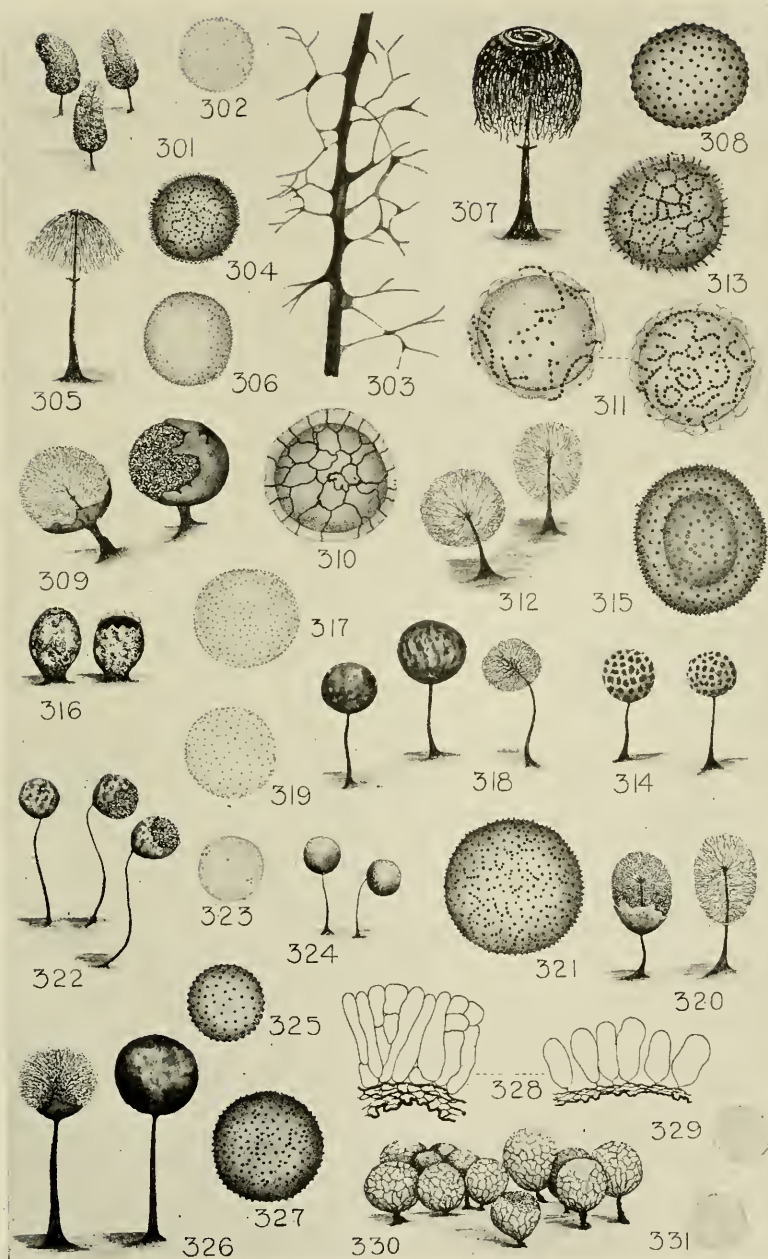
*Lindbladia effusa* (Ehr.) Rost.

Figs. 328, 329. Sections of 2 different pseudo-æthalia showing variation in form,  $\times 7$ ; spore,  $\times 1200$ .

*Cribraria argillacea* Pers.

Figs. 330, 331. Habit,  $\times 7$ ; spore,  $\times 1200$ .

# PLATE XIII





## EXPLANATION OF PLATE XIV

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*Cribraria splendens* (Schrad.) Pers.

Figs. 332, 333. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Cribraria microcarpa* (Schrad.) Pers.

Figs. 334, 335, 336. Habit,  $\times 15$ ; nodes and spore,  $\times 550$ ; node and spores,  $\times 1200$ .

*Cribraria intricata* Schrad.

Figs. 337, 338, 339. Habit,  $\times 15$ ; net,  $\times 550$ ; spore,  $\times 1200$ .

*Cribraria dictydioides* Cooke & Balf.

Figs. 340, 341, 342. Habit,  $\times 15$ ; net,  $\times 550$ ; spore,  $\times 1200$ .

*Cribraria minutissima* Schw.

Figs. 343, 344, 345. Habit,  $\times 50$ ; net,  $\times 550$ ; spore,  $\times 1200$ .

*Cribraria cuprea* Morg.

Figs. 346, 347. Habit,  $\times 20$ ; spore,  $\times 1200$ .

*Cribraria oregana* Gilbert

Figs. 348, 349. Habit,  $\times 40$ ; spore,  $\times 1200$ .

*Cribraria piriformis* Schrad.

Figs. 350, 351, 352. Habit,  $\times 25$ ; margin of the calyculus,  $\times 250$ ; spore,  $\times 1200$ .

*Cribraria macrocarpa* Schrad.

Figs. 353, 354. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Cribraria tenella* Schrad.

Figs. 355, 356. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Cribraria aurantiaca* Schrad.

Figs. 357, 358. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Cribraria purpurea* Schrad.

Figs. 359, 360. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Cribraria elegans* Berk. & Curt.

Figs. 361, 362. Habit,  $\times 20$ ; spore,  $\times 1200$ .

*Cribraria violacea* Rex

Figs. 363, 364. Habit,  $\times 30$ ; spore,  $\times 1200$ .

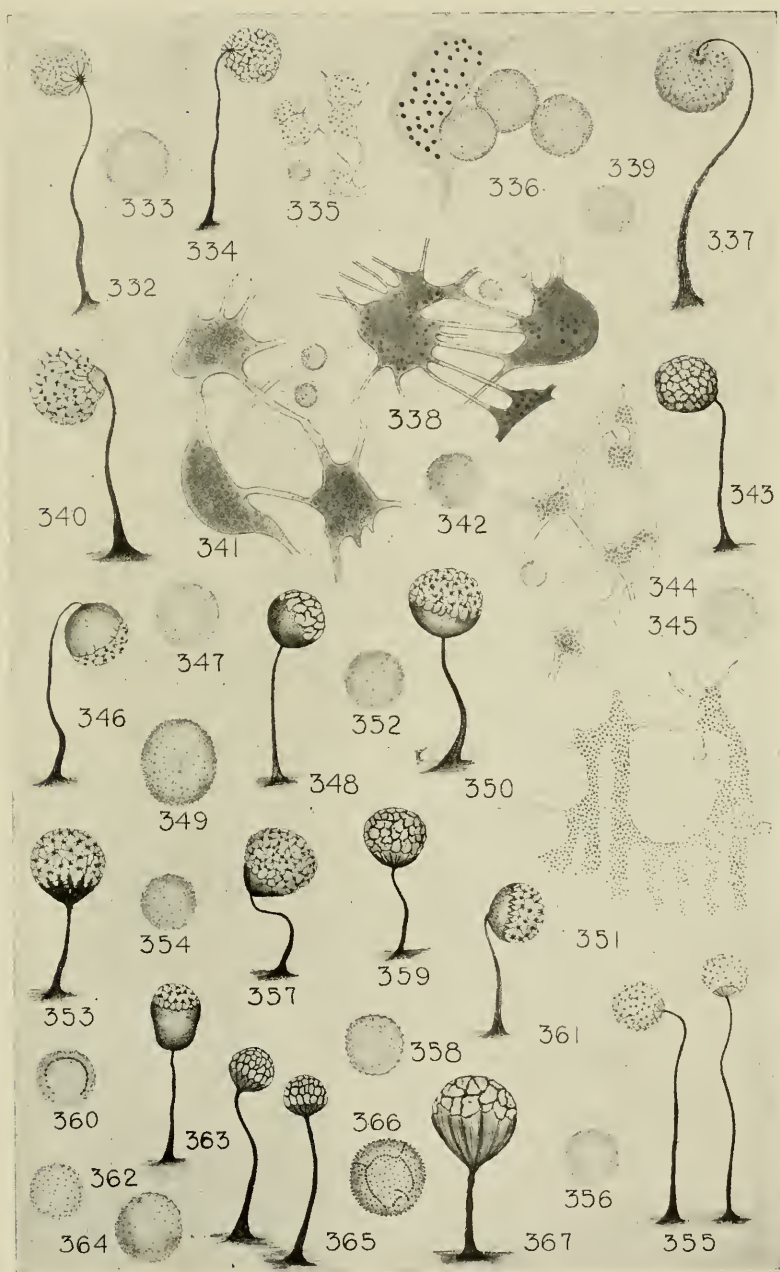
*Cribraria dictyospora* Martin & Lovejoy

Figs. 365, 366. Habit,  $\times 15$ ; spore,  $\times 1200$

*Cribraria rufa* (Roth) Rost.

Fig. 367. Habit,  $\times 20$ .

# PLATE XIV



## EXPLANATION OF PLATE XV

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*Cribraria atrofusca* Martin & Lovejoy

Figs. 368, 369, 370. Habit,  $\times 15$ ; net and spore,  $\times 550$ ; spore,  $\times 1200$ .

*Dictydium cancellatum* (Batsch) Macbr.

Figs. 371, 372. Habit,  $\times 20$ ; spore and granule,  $\times 1200$ .

*Licea variabilis* Schrad.

Figs. 373, 374. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Licea biforis* Morg.

Figs. 375, 376. Habit,  $\times 50$ ; spore,  $\times 1200$ .

*Licea minima* Fr.

Figs. 377, 378. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Licea hungarica* Moesz

Fig. 379. Spores,  $\times 1200$ .

*Licea fimicola* Dearness & Bisby

Figs. 380, 381. Spore from type,  $\times 1200$ ; spores from Bisby,  $\times 1200$ .

*Tubifera ferruginosa* (Batsch) Gmel.

Figs. 382, 383. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Tubifera stipitata* (Berk. & Rav.) Macbr.

Figs. 384, 385. Habit,  $\times 4$ ; spore,  $\times 1200$ .

*Enteridium rozeanum* Wing.

Figs. 386, 387, 388. Habit,  $\times 1$ ; bands,  $\times 60$ ; spores,  $\times 1200$ .

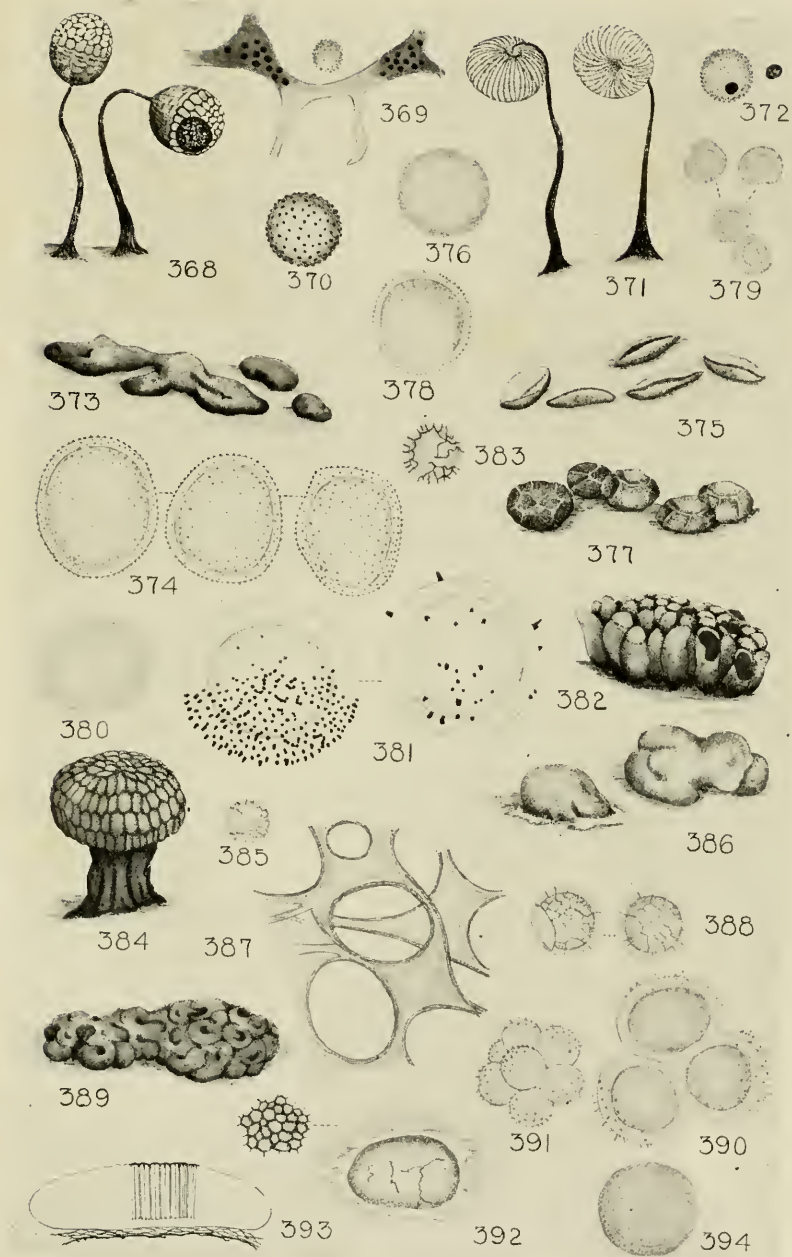
*Enteridium olivaceum* Ehr.

Figs. 389, 390, 391. Habit,  $\times 4$ ; spores,  $\times 1200$ ; spores in clump,  $\times 550$ .

*Dictydiæthaliæ plumbeum* (Schum.) Rost.

Figs. 392, 393, 394. Habit,  $\times 1$ , with enlarged portion of surface to show hexagonal caps,  $\times 15$ ; diagram of structure,  $\times 7$ ; spore,  $\times 1200$ .

# PLATE XV



EXPLANATION OF PLATE XVI

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*Barbeyella minutissima* Meylan

Figs. 395, 396. Habit,  $\times 50$ ; spore,  $\times 1200$ .

*Hymenobolina parasitica* Zukal

Figs. 397, 398. Habit,  $\times 75$ ; spore,  $\times 1200$ .

*Orcadella operculata* Wing.

Figs. 399, 400. Habit,  $\times 25$ ; spore,  $\times 1200$ .

*Liceopsis lobata* (List.) Torr.

Figs. 401, 402. Habit,  $\times 10$ ; spores,  $\times 1200$ .

*Reticularia lycoperdon* Bull.

Fig. 403. Spore,  $\times 1200$ .

*Lycogala epidendrum* (L.) Fr.

Figs. 404, 405. Habit,  $\times 2$ ; spore,  $\times 1200$ .

*Lycogala flavo-fuscum* (Ehr.) Rost.

Figs. 406, 407. Habit,  $\times \frac{1}{2}$ ; spore,  $\times 1200$ .

*Lycogala exiguum* Morg.

Figs. 408, 409. Habit,  $\times 7$ ; spore,  $\times 1200$ .

*Lycogala conicum* Pers.

Figs. 410, 411. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Listerella paradoxa* Jahn

Figs. 412, 413, 414. Section of a sporangium,  $\times 50$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Margarita metallica* (Berk. & Br.) List.

Figs. 415, 416. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Dianema corticatum* List.

Fig. 417. Spores from a collection of Miss Lister's,  $\times 1200$ .

*Dianema harveyi* Rex

Figs. 418, 419. Capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Dianema depressum* List.

Figs. 420, 421, 422. Three threads joining,  $\times 550$ ; a single thread,  $\times 1200$ ; spore,  $\times 1200$ .

*Ophiotheca vermicularis* (Schw.) Massee

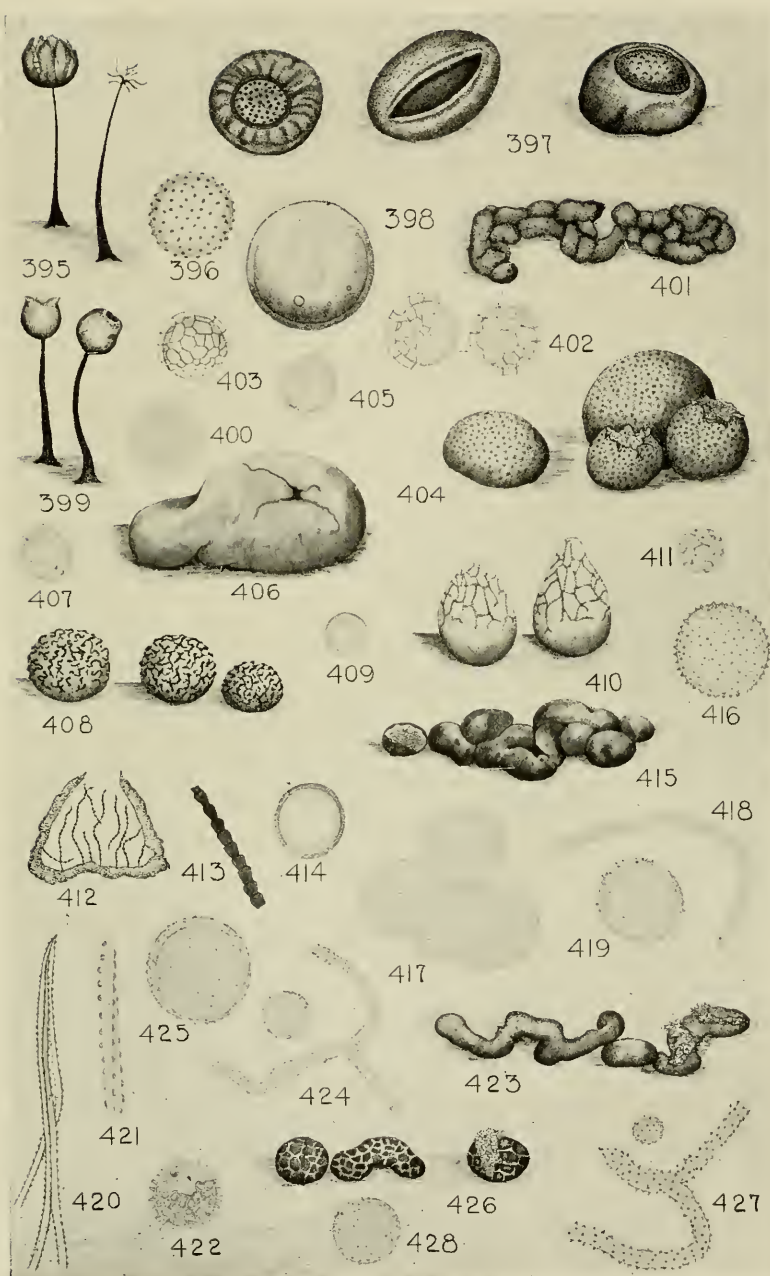
Figs. 423, 424, 425. Habit,  $\times 10$ ; spore and capillitium,  $\times 550$ ; spore,  $\times 1200$ .

*Ophiotheca chrysosperma* Currey

Figs. 426, 427, 428. Habit,  $\times 15$ ; capillitium and spore,  $\times 550$ ; spore,  $\times 1200$ .



# PLATE XVI



## EXPLANATION OF PLATE XVII

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*Ophiotheca wrightii* Berk. & Curt.

Figs. 429, 430, 431, 432. Habit,  $\times 10$ ; capillitium and spore,  $\times 550$ ; capillitium and spore to show variation,  $\times 550$ ; spore and detail of spine from the same collection as Fig. 431; both,  $\times 1200$ .

*Perichæna depressa* Lib.

Figs. 433, 434. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Perichæna quadrata* Macbr.

Figs. 435, 436, 437, 438. Habit,  $\times 10$ ; capillitium and spore,  $\times 550$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Perichæna corticalis* (Batsch) Rost.

Figs. 439, 440. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Perichæna marginata* Schw.

Figs. 441, 442. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lachnobolus congestus* (Somm.) List.

Figs. 443, 444, 445. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Arcyria magna* Rex

Figs. 446, 447, 448, 449. Habit,  $\times 5$ ; capillitium,  $\times 1200$ ; spore from an Iowa collection,  $\times 1200$ ; spore from Rex's collection,  $\times 1200$ .

*Arcyria ærstedtii* Rost.

Figs. 450, 451, 452. Habit,  $\times 5$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Arcyria nulans* (Bull.) Grev.

Figs. 453, 454, 455. Habit,  $\times 5$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

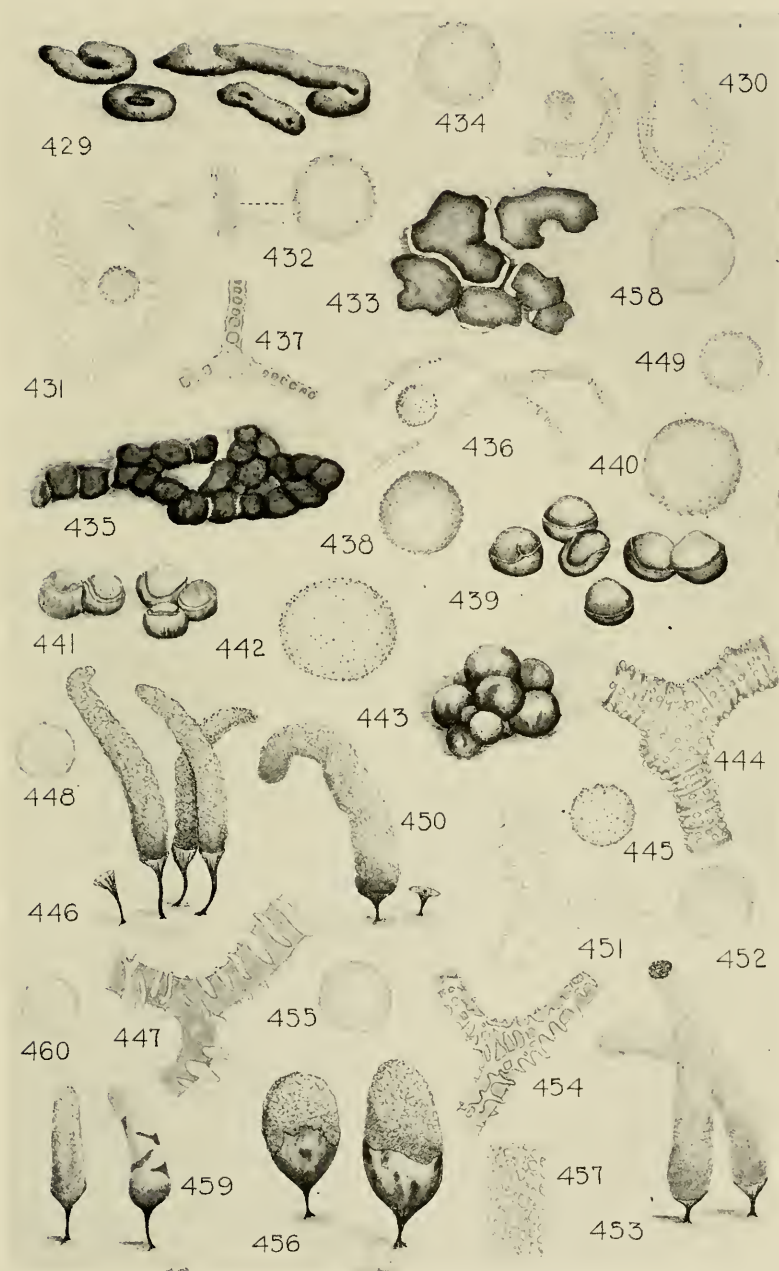
*Arcyria versicolor* Phill.

Figs. 456, 457, 458. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Arcyria cinerea* (Bull.) Pers.

Figs. 459, 460. Habit,  $\times 10$ ; spore,  $\times 1200$ .

# PLATE XVII



## EXPLANATION OF PLATE XVIII

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*Arcyria incarnata* Pers.

Figs. 461, 462, 463. Habit,  $\times 7$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Arcyria ferruginea* Sauter

Figs. 464, 465. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Lachnobolus globosus* (Schw.) Rost.

Figs. 466, 467. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Arcyria pomiformis* (Leers) Rost.

Figs. 468, 469, 470. Habit,  $\times 25$ ; capillitium with forked and unforked free ends,  $\times 1200$ ; spore,  $\times 1200$ .

*Arcyria digitata* (Schw.) Rost.

Figs. 471, 472. Habit,  $\times 5$ ; spore,  $\times 1200$ .

*Arcyria denudata* (L.) Wetts.

Figs. 473, 474, 475. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Lachnobolus occidentalis* Macbr.

Figs. 476, 477. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Prototrichia metallica* (Berk.) Masee

Figs. 478, 479, 480. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Oligonema flavidum* Peck

Figs. 482, 483, 484, 485, 488. Spores,  $\times 1200$ ; habit,  $\times 10$ ; short, thick elater of *brevifilum* type,  $\times 600$ ; portion of longer, thinner elater,  $\times 1200$ .

*Oligonema fulvum* Morg.

Figs. 486, 487. Capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Oligonema nitens* (Lib.) Rost.

Figs. 481, 489. Elater,  $\times 1200$ ; spore,  $\times 1200$ .

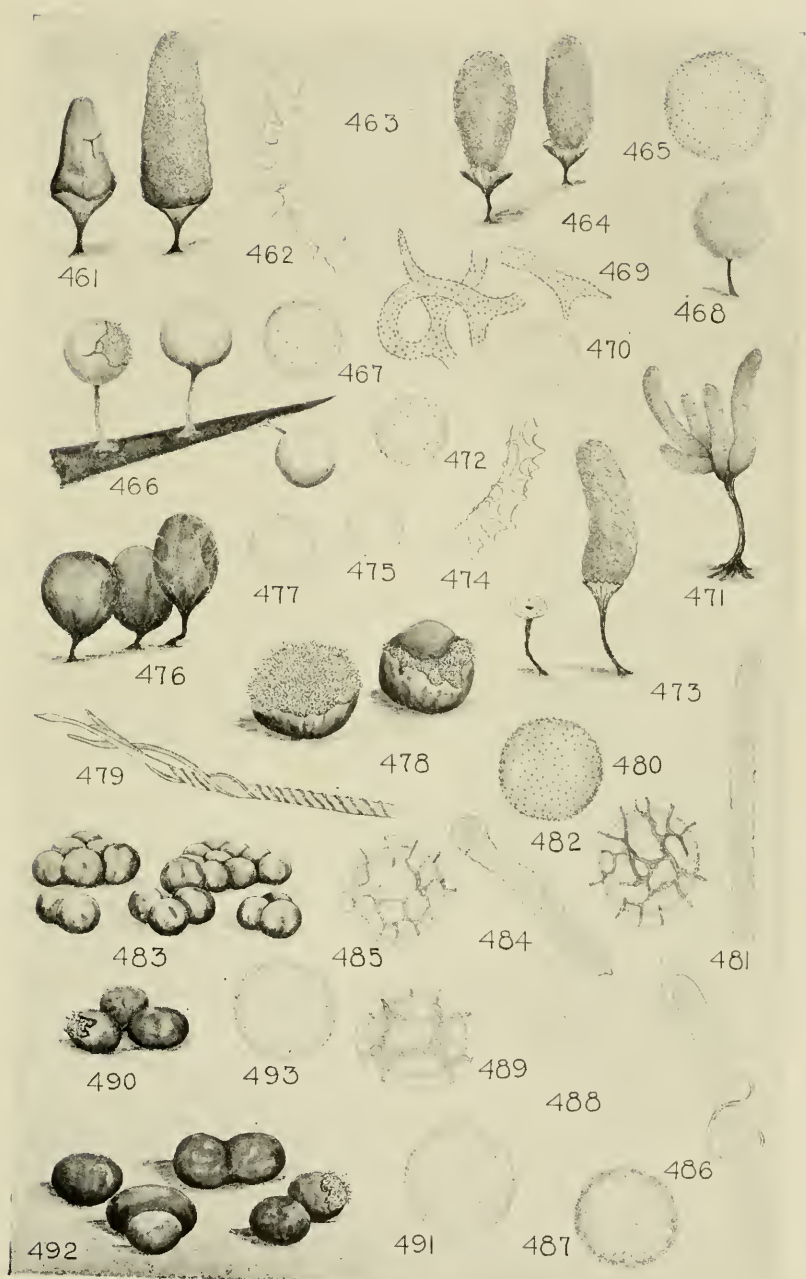
*Trichia contorta* (Ditm.) Rost.

Figs. 490, 491. Habit,  $\times 15$ ; spore,  $\times 1200$ .

*Trichia inconspicua* Rost.

Figs. 492, 493. Habit,  $\times 15$ ; spore,  $\times 1200$ .

# PLATE XVIII





## EXPLANATION OF PLATE XIX

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*Trichia inconspicua* Rost.

Fig. 494. Capillitium,  $\times 1200$ .

*Trichia contorta* (Ditm.) Rost.

Fig. 495. Capillitium,  $\times 1200$ .

*Trichia iowensis* Macbr.

Figs. 496, 497, 498. Habit,  $\times 15$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Trichia varia* Pers.

Figs. 499, 500, 501. Habit,  $\times 15$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Trichia scabra* Rost.

Figs. 502, 503. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Trichia favoginea* (Batsch) Pers.

Figs. 504, 505, 506. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spores,  $\times 1200$ .

*Trichia pulchella* Rex

Figs. 507, 508, 509. Habit,  $\times 15$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Trichia persimilis* Macbr.

Figs. 510, 511. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Trichia verrucosa* Berk.

Figs. 512, 513. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Trichia erecta* Rex

Figs. 514, 515. Habit,  $\times 15$ ; spore,  $\times 1200$ .

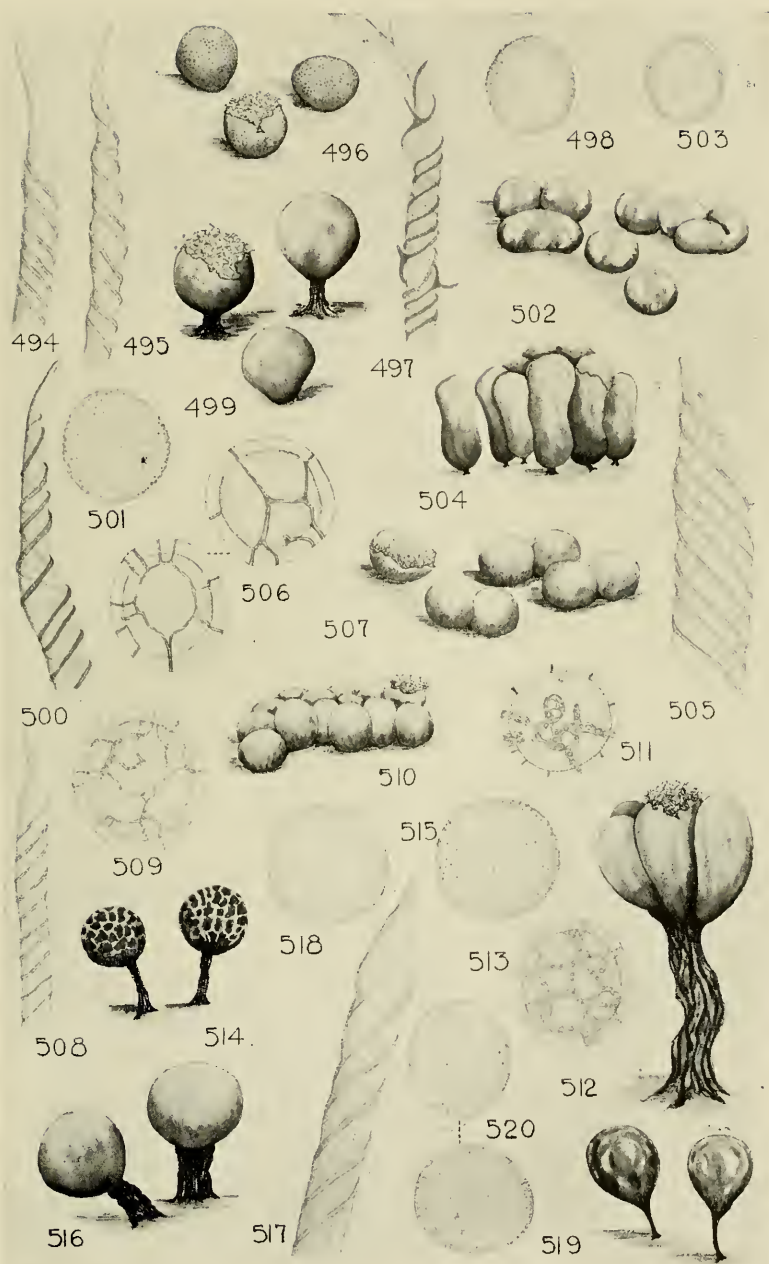
*Trichia subfusca* Rex

Figs. 516, 517, 518. Habit,  $\times 15$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Trichia decipiens* (Pers.) Macbr.

Figs. 519, 520. Habit,  $\times 15$ ; spores,  $\times 1200$ .

# PLATE XIX



## EXPLANATION OF PLATE XX

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*Trichia botrytis* (Gmel.) Pers.

Figs. 521, 522. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Trichia floriformis* (Schw.) G. List.

Fig. 523. Habit,  $\times 10$ .

*Hemitrichia serpula* (Scop.) Rost.

Figs. 524, 525, 526. Habit,  $\times 5$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia stipata* (Schw.) Macbr.

Figs. 527, 528, 529. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia ovata* (Pers.) Macbr.

Figs. 530, 531, 532. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia vesparium* (Batsch) Macbr.

Figs. 533, 534, 535. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia clavata* (Pers.) Rost.

Figs. 536, 537, 538. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia stipitata* (Masse) Macbr.

Figs. 539, 540. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Hemitrichia montana* (Morg.) Macbr.

Figs. 541, 542. Habit,  $\times 10$ ; spore,  $\times 1200$ .

*Hemitrichia karstenii* (Rost.) List.

Figs. 543, 544. Capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Hemitrichia leiocarpa* (Cke.) List.

Figs. 545, 546. Capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

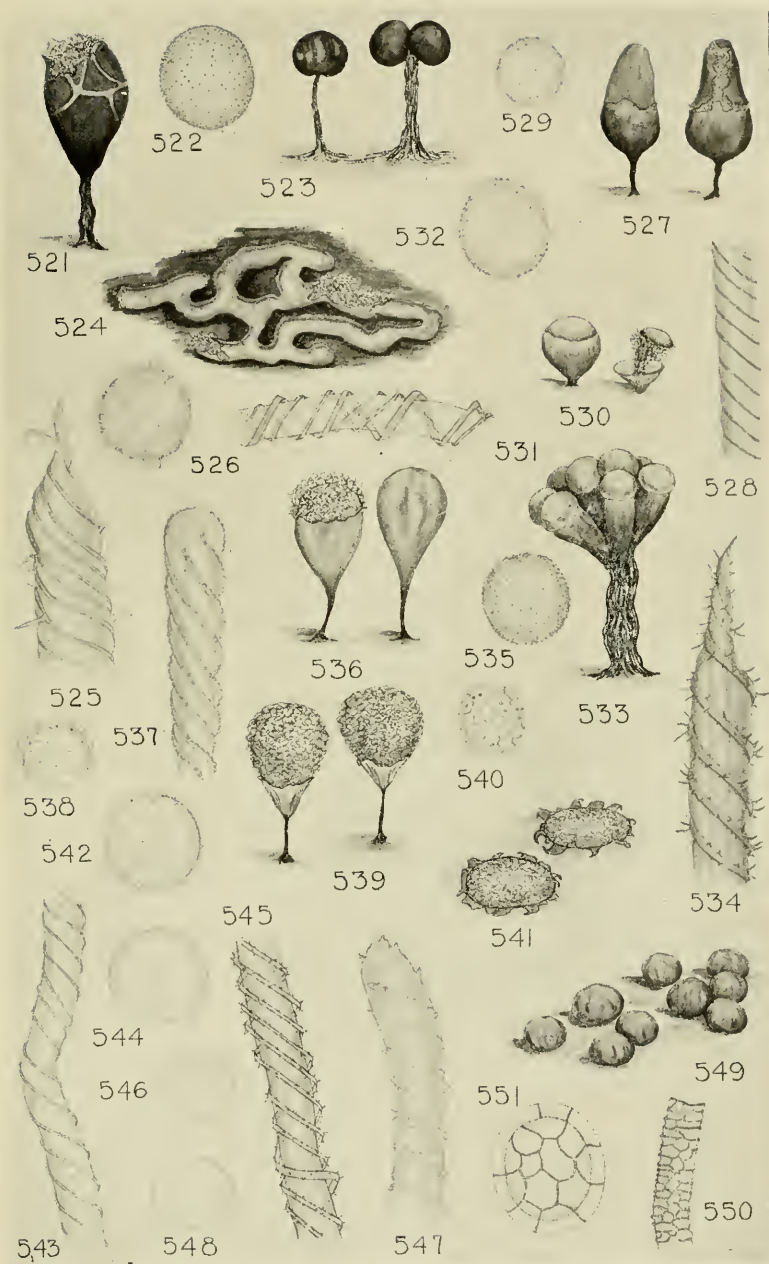
*Hemitrichia intorta* List.

Figs. 547, 548. Capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

*Calonema aureum* Morg.

Figs. 549, 550, 551. Habit,  $\times 10$ ; capillitium,  $\times 1200$ ; spore,  $\times 1200$ .

# PLATE XX



## EXPLANATION OF PLATE XXI

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*Echinostelium minutum* de Bary

Figs. 552, 553. Habit,  $\times 130$ ; detail of sporangium without the peridium,  $\times 550$ .

*Clastoderma debaryanum* Blytt

Fig. 554. Habit,  $\times 65$ .

*Kleistobolus pusillus* Lipp.

Figs. 555, 556, 557, 558. Section,  $\times 550$ ; detail of operculum,  $\times 550$ ; detail of outer edge of the operculum,  $\times 1200$ ; spores,  $\times 1200$ .

*Physarum vernum* Somm.

Fig. 559. Spore,  $\times 1200$ .

*Physarum confertum* Macbr.

Fig. 560. Spore,  $\times 1200$ .

*Hemitrichia minor* G. List.

Figs. 561, 565. Vesicular thickenings of the capillitium in a culture collection,  $\times 550$ ; a globose sporangium with circumscissile dehiscence, from culture,  $\times 20$ .

*Dianema corticatum* List.

Fig. 562. Clump of typical spores,  $\times 1200$ .

*Schenella simplex* Macbr.

Figs. 563, 564. Section showing the capillitial columns which support the peridium,  $\times 15$ ; after Macbride; a single column with component threads,  $\times 30$ ; after Macbride.

*Diderma chondriodermis* (de B. & R.) G. List.

Figs. 566, 567, 568, 569. Habit,  $\times 10$ ; dark capillitial thread,  $\times 550$ ; pale capillitium and spore,  $\times 550$ ; spore,  $\times 1200$ .

*Craterium aureum* (Schum.) Rost.

Figs. 570, 571. Habit to show internal character,  $\times 10$ ; capillitium,  $\times 550$ .

*Alwisia bombardia* Berk. & Br.

Fig. 572. Habit,  $\times 12$ .

*Physarina echinocephala* von Höhnelt

Fig. 573. Section of a sporangium,  $\times 30$ . After von Höhnelt.



# PLATE XXI

